THIRD SERIES VOL 62 NUMBER 6 APRIL 1955

66 PORTLAND PLACE LONDON W1 · TWO SHILLINGS AND SIXPENCE

Flats in Milan. Architect, Vita Latis. Photograph by Timothy Rendle [A]

THE JOURNAL OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS

THIRD SERIES VOLUME SIXTY-TWO NUMBER SIX TWO SHILLINGS AND SIXPENCE
66 PORTLAND PLACE LONDON W1 TELEPHONE LANGHAM 5721-7 TELEGRAMS: RIBAZO WESDO LONDON

APRIL 1955

Knights of the Thistle

Her Majesty the Queen has conferred the Order of the Knight of the Thistle on The Earl of Crawford and Balcarres, G.B.E. [*Hon. F*], and The Lord Bilsland of Kinrara, M.C., D.L., LL.D. [*Hon. A*].

The R.I.B.A. Reception

The programme for the Royal Institute's Annual Reception, to be held on 20 May, has now been settled. The President and Mrs. Aslin will receive members and guests in the Henry Florence Memorial Hall from 8.15 to 9 p.m. From 9 p.m. to midnight there will be dancing to George Jay's orchestra. In the Henry Jarvis Hall there will be two recitals of music for two pianos given by Mr. Miles Coverdale and Mr. Alexander Kelly at 9.30 p.m. and 10.15 p.m. The Library is staging an exhibition entitled 'Oriental Scenery' from the drawings and books in the R.I.B.A. collection. There will be two refreshment buffets and a bar.

Building Wages

Discussing the recent wage increase in the building industry, the Labour Correspondent of THE FINANCIAL TIMES, writing on 16 March, gave some interesting facts about the operatives' side of the industry. Unlike some other industries, he said, the wage structure of the building industry was a very simple one in that there were only two recognised grades—craftsmen and labourers—and that all craftsmen received the same rate. About 55 per cent of building workers were craftsmen and 45 per cent labourers. No move had yet been made to provide for semi-skilled grades, although mechanisation was tending to make the rigid craftsman-labourer distinction out of date. The craft unions in some cases showed reluctance in accepting mechanisation, which took the form of punctiliousness about demarcation rights. The employers had hinted that they would be more willing to accept wage demands if they could be assured of a more co-operative attitude from the unions. In this connection, the writer pointed out that U.S. building workers' wages were four to six times as high as in the U.K. and that their output per man-hour was frequently three times as high.

The employers, he said, were also anxious to widen the differential between labourers and craftsmen. At present craftsmen received only 12 per cent more than labourers, compared with 25 per cent before the war. During their apprenticeship, craftsmen earned less than labourers.

Exhibition of Mexican Architecture at the R.I.B.A.

At the time of our going to press with this JOURNAL, the Mexican exhibition which was scheduled to be on view at the R.I.B.A. from 15 April to 2 May had not arrived in this country, neither had any advance photographs been received which we could have reproduced to give members an idea of the nature of the exhibition. It is hoped that it will be on view at the R.I.B.A. towards the end of the month. We regret that we shall be able to do no more than publish some retrospective pictures in the May JOURNAL.

Architect President of the Royal Canadian Academy

Mr. Hugh L. Allward [*F*] has been elected President of the Royal Canadian Academy.

R.I.B.A. Exhibition 'Your House'

When this exhibition visited their city recently, the architects of Bath staged a public meeting to discuss the art of making a home. Every chair in the Victoria Art Gallery was occupied when a team of architects and the president of the Bath Association of the N.F.B.T.E. opened the discussion. The architect speakers included Miss Molly Taylor [*F*] (Mrs. R. A. Gerrard), Mr. F. R. Huggins [*A*] and Mr. Robert Townsend [*A*]. Mr. H. H. Goldsmith [*F*] was in the chair.

This appears to be an excellent method of drawing public attention to the exhibition and one that might well be emulated by other groups of architects and the Allied Societies. Members of the public are always willing to air their views on house design and such a discussion is a sure 'draw'.

S.P.A.B. Annual Course on the Repair of Ancient Buildings

The Society for the Protection of Ancient Buildings is again arranging its annual Course, consisting of lectures, discussions and visits.

The Society is anxious that more architects should understand not only traditional constructional methods but also the principles underlying the sympathetic and conservative treatment of old buildings, whether ecclesiastical or secular, and hopes that local authorities and others will be able to give facilities to the architect members of their staff to take advantage of the scheme.

The Course will be held from 16 to 21 May. Further details may be obtained from the Secretary, The Society for the Protection of Ancient Buildings, 55 Great Ormond Street, London, W.C.1.

The Symposium on High Flats

A full report of the recent symposium, giving the papers verbatim and reproducing most of the slides, is being printed; copies will be available about the middle of May. The cost will be 6*s*. per copy or 6*s*. 6*d*. by post. Application, accompanied by cheque or postal order, should be made to the Secretary R.I.B.A., 66 Portland Place, W.1. Copies can also be bought at the inquiry counter of the R.I.B.A. Early application is advisable.

Very little information has hitherto been published on low cost dwellings in high blocks. Covering as it does the planning, structural, technical and social aspects in a series of contributions by acknowledged experts, this report forms a valuable text book. It will have a special preface written by Dr. Leslie Martin [*F*], Architect to the London County Council.

The Building Centre

Sir Giles Gilbert Scott, O.M., R.A. [*F*], was in the chair at the annual luncheon of the Building Centre held on 30 March. This is the occasion when the Council of the Centre collect together their Fellows, chief government officers, principal exhibitors, the editors of the architectural periodicals and other persons prominent in the building industry to report on their proceedings during the past year. This year the report was made in the form of a printed brochure of which each guest was given a copy. There was only one speech, made by Sir Harold Emmerson, Permanent Secretary of the Ministry of Works, who briefly thanked the Council on behalf of the guests. The principal guest was Mr. Duncan Sandys, Minister of Housing and Local Government.

Founded in 1931 as a place where architects and others could see and compare building materials without being bothered by sales talk, the Building Centre has prospered steadily until, in 1954, enquiries have amounted to 73,165 personal, 21,391 by telephone and 2,701 by letter; more than 300,000 exhibitors' information sheets have been handed out or sent by post. The creation of its Director, Mr. F. R. Yerbury, O.B.E. [*Hon. A*], the Building Centre has provided a permanent exhibition and information service for nearly a quarter of a century and has served as a model for similar institutions in various parts of the world.

The Scottish County, City and Burgh Architects' Joint Association

This Association, founded in 1952, has a membership comprising the Chief Official Architects and their Deputies in the Local Government service throughout Scotland. The objects of the Association are briefly to collate and discuss information affecting salaries, service conditions and duties and to safeguard and uphold the interests and status of its members as well as to provide a means whereby their knowledge and experience can be made available to its own members and to their Councils.

The Executive Committee consisting of Chairman (A. G. Jury [*F*], City Architect and Planning Officer, Glasgow), Vice-Chairman (G. Bartholomew [*A*], County Architect, Dumfries), Hon. Secretary and Treasurer (W. H. Henry [*L*], County Architect and Planning Officer, Alloa) and four County Architects, two Burgh Architects and one City Architect meet regularly. The Association meets quarterly in Edinburgh at the Headquarters of the Royal Incorporation of Architects in Scotland. The Annual General Meeting is held in March.

The Association has two permanent seats on the Joint Negotiating Committee for Chief Officials of Local Authorities in Scotland. In addition to its business meetings the Association invites guest speakers to address its members after quarterly meetings. Speakers during the past year included Mr. T. A. Jeffryes, D.A.(Edin.), A.M.T.P.I. [*A*], Chief Architect and Planning Officer to the Department of Health for Scotland, and Mr. S. A. Johnson-Marshall, C.B.E., B.Arch. [*A*], Chief Architect, Ministry of Education.

The R.I.B.A. and Industrial Architecture

The above illustration shows the R.I.B.A. exhibit at the recent National Factory Equipment Exhibition. The stand which was designed by Mr. Kenneth Bayes [*A*] attracted a great deal of attention at the exhibition, chiefly we suspect because it was considerably better designed than the majority; that was as it should be when one of the 'products' being 'sold' on the stand was good design. This is a good example of the kind of propaganda for architecture and the services of architects which the R.I.B.A. Public Relations Committee undertakes. Several members gave their services voluntarily as stand attendants.

The New Year Honours List

We regret that the following honour conferred on a member was omitted from the New Year Honours list published in the January JOURNAL:—O.B.E. (Civil) for Mr. David Butler Mills [*A*].

Sir Arthur Stephenson in the U.S.A.

Sir Arthur Stephenson [*F*], Royal Gold Medallist in 1954, has been touring the United States in order to study American hospital design. It appears from evidence in the American architectural papers that Sir Arthur has been almost as warmly welcomed as he was in Great Britain last year.

The British Colour Council

The Thirteenth Designers' Conference of the British Colour Council is to be held at the Council's headquarters in London from 2 to 6 May. There is to be a panel of speakers on different aspects of the theme 'A Quest for Colour', talks on colour and lighting in relation to the modern interior, visits and films. An exhibition of paintings, drawings, ceramics and textiles will be on view. Persons who are not members of the Council are invited to attend. Information is obtainable from the British Colour Council, 13 Portman Square, W.1.

Architect Mayor

Mr. G. T. Harman [*F*] is the mayor elect of the Metropolitan Borough of Lewisham for the year 1955–56.

R.I.B.A. Diary

MONDAY 25 APRIL. 6 P.M. Library Group Meeting. *The Scope and Limits of Vitruvian Influence in Town Planning*—introduced by Dr. Helen Rosenau.

TUESDAY 3 MAY. 6 P.M. Annual General Meeting.

TUESDAY 17 MAY. 6 P.M. General Meeting. *Conditions of Building in City Centres*—Professor Sir William Holford, M.T.P.I. [*F*].

FRIDAY 20 MAY. 8.15 P.M. R.I.B.A. Annual Reception.

Comparisons in Modern Structural Steelwork

By W. Fisher Cassie, Ph.D., M.S., F.R.S.E., M.I.C.E., M.I.Struct.E. and
D. W. Cooper, B.Sc.(Eng.), A.M.I.Struct.E.

A Science Lecture at the Royal Institute of British Architects, 22 March, 1955
Mr. Basil Spence, O.B.E., A.R.A., A.R.S.A., Vice-President, in the Chair

PART I: Read by Professor Fisher Cassie

AS THE DEVELOPMENT of civilisation accelerates, the productions of human ingenuity increase in complexity and in the power of their influence on life. We are surrounded by miracles, but we treat them too often as commonplace. We become too accustomed to wonders. The miracle of television—for it is no less—fills us with no awe. We use it for parlour games, or as the target of critical letters to the press! The marvellous transformation of matter into energy by nuclear fission does not strike us dumb at the wonders of the universe. We merely add this miracle to our armoury of destruction and talk its wonder away at interminable conferences.

It is unnecessary in this company to stress the argument that all creative achievements are more influenced by mental conceptions than by material circumstances. Architecture provides, in fact, the most striking examples of the physical manifestation of the creative idea. The work of an architect who thinks out his problems afresh is as unmistakably stamped with the signs of his personality as are his physical features.

The theme of this first part of the paper, then, is that ideas are more important than physical details even in such an apparently ordinary material as structural steel. We cannot claim for this method of building a place in the hierarchy of miracles beside television, atomic energy and the jet engine, but perhaps we get too accustomed even to our building materials. To the architects of even a century ago modern structural steel would have appeared as something of a godsend in the original use of the word. Let us look at the steel frame again, and decide whether the human brain, so fertile in mechanical, electrical and aeronautical engineering, is diverting enough of its creative power to building.

If one examines most of the structural steelwork of the present day, one finds that it has not progressed far beyond the pillar and beam construction by which the ancient Egyptians produced such enduring results. Only in a relatively few structures does one find the capacity of steel to withstand stress utilised in all its parts. Much of what is fabricated is useless dead weight, very lightly stressed and requiring for its support still more steel. This was recognised long ago for it was in 1929, twenty-six years ago, that the British Steelwork Association pointed out how little advantage was being taken of the excellent qualities of structural steel. Codes of practice were restrictive, and wasteful of one of our most valuable building materials. The story of the next decade shows, unfortunately, that designers of buildings are often not as receptive of mental revolutions as are the designers of aircraft, for the results of seven years of intensive study in the search for a logical method of design were tacitly rejected by the building profession.

The story begins in 1930 when the new Steel Structures Research Committee had got to work. They made it their first task to review existing methods of steelwork design and to embody them in a 'Code of Practice for the use of Structural Steel in Building'. The result of this step seems to indicate that designers of structural steelwork heaved a sigh of relief and said 'Here at last are rules we can follow. We won't have to think any more'. The fact that the Code was based on existing methods rather than on any logical development made no difference—for the next 17 years the methods of the 1920s frozen in B.S.S. 449 became the standard procedure. The Steel Structures Research Committee pointed out in vain that the methods described in the Code were almost entirely irrational and incapable of refinement. There was no response, and, until 1948, B.S.S. 449 was gospel.

Through the '30s until the issue of their Final Report in 1936, the Steel Structures Research Committee laboured to find a rational method of design. Laboratory experiments were matched, for the first time, with successful tests on full-scale buildings in the course of erection. The Cumberland Hotel and the Geological Museum, then under construction, were loaded and tested in many ways and the stresses in the frames measured on the bare steel and on the cladded beams and columns. It was found, as had been expected, that the usual beam-to-column connection was not the simple free joint that it was supposed to be by current design methods. Brackets and cleats were capable of taking some moment and of transferring that moment 'round the corner' into the stanchion. This diffusion of the bending was not as complete as it would have been with truly rigid joints, but the amount of moment transferred increased as the stiffness of the joint increased until with complete concrete encasement a fully rigid joint could be assumed.

The Steel Structures Research Committee then classified six beam-to-stanchion connections of various orders of stiffness and, with these grades of stiffness as a guide, built up design methods for both beams and stanchions. One of the difficulties of dealing with continuous or nearly continuous structures is that a direct design cannot be made. It is not possible to work logically from loads through to the final beam and stanchion sections. The properties of the proposed sections must first be assumed and from these properties the adequacy of the proposed beams and stanchions to carry the applied moments can be determined. If the sections are found to be inadequate, a fresh start must be made.

The method, following these lines, which was developed by the Steel Structures Research Committee was logical and rational. Its procedure was based on how steel frames actually behave under load, and it eliminated the prejudiced estimates which too often served in the past as design methods. It was, however, much too complex to receive ready acceptance, and when designers found that, although the steel was more efficiently distributed in beams and stanchions, the total weight of the structure was not much decreased, they merely disregarded, and so rejected, the results of seven years of research. The older, more comfortable and simpler methods held sway until 1948, unchanged except for the wartime raising of the allowable stress to 10 tons/in². Even then, the new B.S. 449 (1948) owed little or nothing to the tests on existing buildings and to the researches alluded to above.

There is no doubt that the only sound method of structural steel design *in the elastic range* is that given by the Steel Structures Research Committee's investigations. The fact that this method shows neither economy nor simplicity does not discredit it, but merely indicates that the criterion used as a guiding principle cannot lead to much more economic design than do the rule of thumb methods of an earlier generation. That criterion was that at no point in a structure must the stress rise above a defined 'safe' value. We must search for another.

What then is the answer? It was clear, in these seven pre-war years, that the moments acting in beams and stanchions depend closely on the properties of the sections which comprise the different parts of the frame. If the beam-to-column connections were rigid or semi-rigid no one beam or one stanchion length could be designed independently of the others; the structural frame had to be considered as a whole. Loads on one beam, for example, or wind forces on one column were not supported by that member alone, but affected stresses in distant parts of the frame.

With this already well understood idea

as a clue and with the failure of their elastic design proposals as a spur, the designers went on to study not safe stresses at isolated points of a frame, but rather the safety of the whole frame against collapse. Like many revolutionary ideas this one seems in restrospect to be obvious and simple. The effect it has had, however, on the appearance and weight of structural steelwork in the few buildings yet erected —the first physical manifestations of this new idea—is much more striking than that produced by the complex rules of the Steel Structures Research Committee's Reports.

The simple idea, that the new criterion in design should be not a 'safe' stress but the collapse load of the whole structure, would not have produced the striking results it has if it had not been for the brilliant work done at the University of Cambridge. Professor J. F. Baker and his teams have for years been working on the theoretical and experimental development of the new conception. This is not an easy task, for although the idea may be simple, the creative thought required to produce a design method is formidable. Professor Baker was the Secretary of the Steel Structures Research Committee and one of its most industrious experimenters, and the reports on his more recent work on the plastic collapse loads of structures are well known internationally.[1, 2, 4] The second volume of his book on *The Steel Skeleton*, which will deal with plastic design, is eagerly awaited, and structural engineers must all be pleased at your Council's action in awarding Professor Baker an Honorary Associateship of this Institute—an honour he certainly deserves. Professor Baker, by the way, gives me permission to mention a letter he received recently from the United States in which La Motte Grover of the American Welding Institute, referring to a paper he read to the American Society of Civil Engineers, praised the method of plastic design. He said he was glad to be able to tell his audience

'. . . of the reception that the method is receiving in England and the several projects that have been executed or are under way at this time; because I had to say that to the best of my knowledge, none of the structural engineers on this side has wittingly taken advantage of this method of design'.

It is often and sometimes justly said that we are slow to apply the results of research in practical construction, and it is pleasant to find this sphere where we have been alive to new ideas.

Under the older conception, using the criterion of a 'safe' stress, the 'unsafe' range of loading was that which produced a yield stress at some point in a beam or column. If loading is continued beyond this point more and more of the metal in the member reaches the plastic state and deforms without increase in stress. The outer fibres of the section where stress is highest are naturally affected first, but finally the whole thickness of the member from top to bottom reaches a plastic state. In this condition the section of high stress at which plasticity has been reached can be considered as a hinge, free to rotate

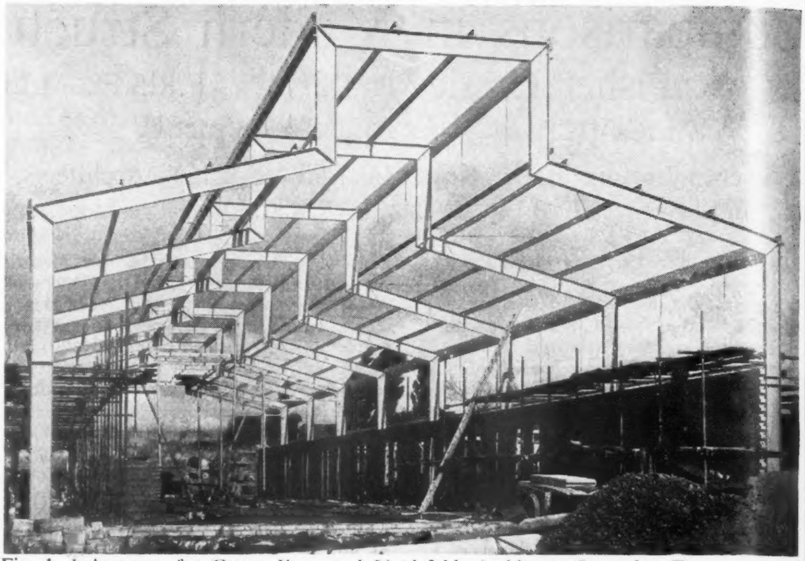


Fig. 1. Laboratory for Guest, Keen and Nettlefold. Architects: Lavender, Twentyman and Percy [*F/A*]. Consulting engineer: Professor J. F. Baker. Designed by the plastic design method. Total covered area 12,100 sq. ft.

Fig. 2. Store building, Rosyth, designed by the plastic design method. Royal Naval official photograph, published by permission of the Admiralty

through a small angle and offering no resistance to movement.[5]

'Hinges' also develop at other points where the stress rises as the load increases and in the end when sufficient plastic zones appear the structure collapses. It is then, technically, a mechanism with one degree of freedom. From the bending moment diagram of, say, a portal frame, it is clear that at the joints between stanchions and rafters and at points of loading there are high stresses caused by large bending moments and at any of these points, as the load is gradually increased, plastic hinges may develop. Four or more of these hinges[3,6] may be required to cause complete collapse depending on the type of portal, and these hinges may occur in different combinations according to the relative stiffness of the beams and columns. It is the task of the designer to estimate in advance which mode of collapse will actually take place and so decide on the true collapse load of the structure. This load, divided by an agreed load factor, gives the working load which can be safely carried by the structure.

During the past few years a particular study of plastic failure has been made on model vierendeel frames in my department. The work, which consists of an investigation of vierendeel frames loaded up to plastic failure, has been conducted by S. Henderson and supervised by Mr. Cooper, my fellow author. Several interesting points have been established in these investigations.

It has been found, for example, that contrary to all expectations, a plastic zone develops, not only in the material *near* a joint, in column or beam, but actually *in* the material of the joint itself, even if the joint is much stiffer than the members

Fig. 3. Transit shed for passengers and cargo, Southampton. Designed by the plastic design method. Consulting engineers: Scott and Wilson, Kirkpatrick and Partners

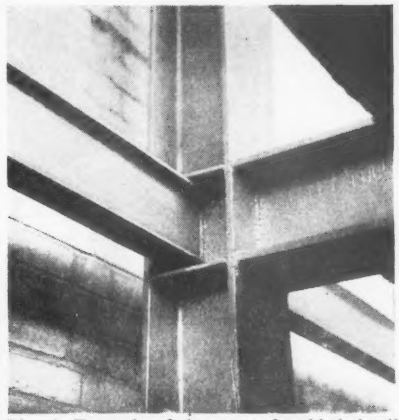


Fig. 4. Example of the type of welded detail achieved by the plastic design method. The main frame in a film-storage building of five storeys, one of the few multi-storey buildings yet designed by this method. Consulting engineers: R. T. James and Partners

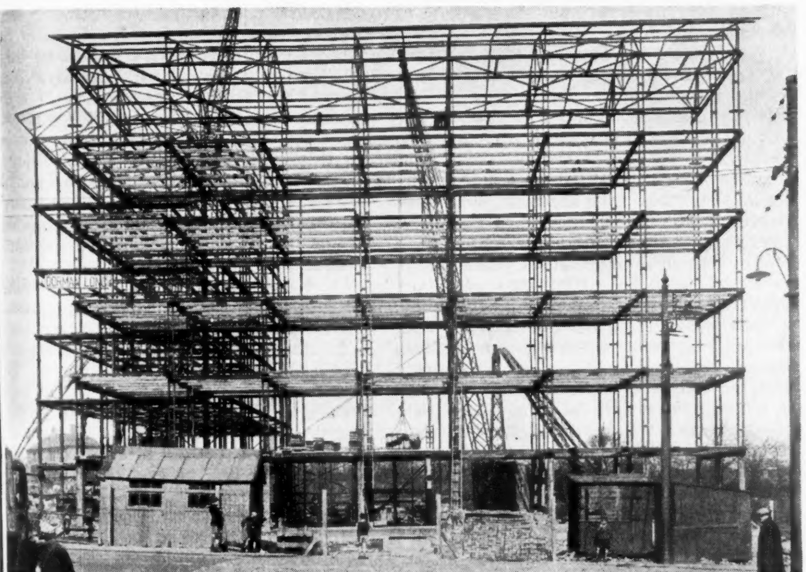


Fig. 5. Hindhaugh Street Flats, Newcastle upon Tyne. Designed by E. Czeiler as a three-dimensional frame, the floors acting as horizontal girders for lateral stiffness

composing it. Also, because of the extra stiffness afforded by short vertical members of a shallow vierendeel frame, deflection under a given load increases with increasing depth over a range of truss proportions. This, again, is contrary to expectation, for we are accustomed to finding that a greater construction depth results in decreased rather than in an increased deflection. If, within defined limits of proportion, shallow beams of the vierendeel type deflect less than the deeper beams, a much wider field of structural and architectural design is opened up. We have called this phenomenon the 'Cooper effect'!

Models, of course, cannot be expected to yield comprehensive answers, but through the valuable co-operation of Mr. A. Dean, Chief Civil Engineer to the North Eastern Division of British Railways, we hope soon to have specially fabricated full-scale vierendeel frames of the type used in signal gantries. Tests of these to destruction should give very valuable information.

The load factor against complete collapse of a beam of I section simply supported and designed in accordance with B.S. 449 (1948) is 1·75 and it is thus consistent and logical to use a load factor of similar value in the design of more complex structures. Assuming then that the collapse load of a structure is somewhat less than twice the working load, and that the value of the collapse load can be determined in advance of construction, we find that plastic design methods result in lighter and more economical steel frames. The more highly redundant the type of construction, the greater is the advantage of plastic design. The plastic design of single bay portals is now well understood and has been expanded to multi-bay portals. Advance has also been made in developing design methods for multi-storey, multi-bay frames.[3]

In the illustrations (Figs. 1 to 4) it is noticeable that the sections used in buildings designed by the plastic method are not only lighter but also more uniform in size than is usual with conventional design. This uniformity tends to maintain working stresses low and normally within the elastic limit. If there is at any joint an abrupt change in section there is more likelihood of plastic stresses being developed at working loads. Permanent strains at points of high stress, and larger deflections are, of course, more likely to develop than with conventional design, and the deflection rather than the strength of a frame may sometimes be the governing factor. The saving in weight of steelwork is given by various reports as about 34 per cent on portal-type frames, but this figure can be considered only as tentative and should not be applied widely. In cost, plastic design competes easily with conventional design, and savings in cost have been reported up to about 20 per cent.

So far we have traced development in thought about structural steelwork from the pillar-and-beam construction (which is still most commonly employed for multi-storey buildings) through the rational and logical proposals of the Steel Structures Research Committee. Both the older

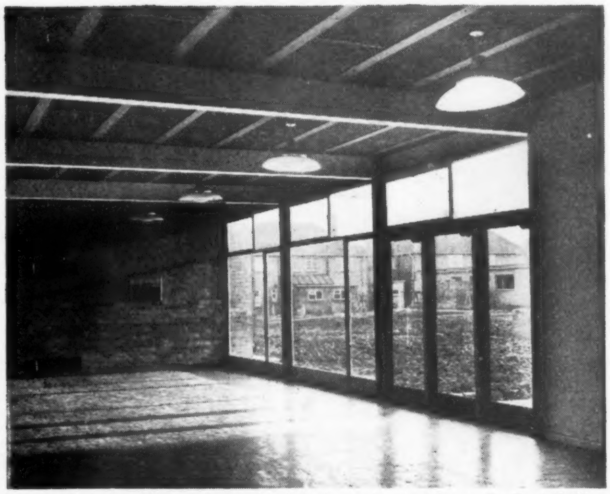


Fig. 6. Berwick Hills School, Middlesbrough. Architect: P. R. Middleton [A]. Cold rolled stanchions, beams and purlins, giving a clean appearance without casing. The fenestration is attached directly to the stanchions

Fig. 7. The Gilbert Colvin School for Ilford Borough Council. Tubular steel space frame by Ove N. Arup and Partners, consulting engineers in conjunction with Scaffolding (Great Britain) Ltd.

method and the Committee's method employed the criterion that the stress at any point must not rise above a given value. Adherence to this criterion resulted in the development of a design method which, though logical, was unacceptable because of its complexity. The abandonment of this criterion—a big step in creative thinking on the problem—brought in its train the method of plastic design and results of great importance. To some it seems likely that the day of elastic design of structural steelwork, as we now know it, will soon be over, except for construction where deflections and sway are important.

But is even plastic design the final stage? After all we are not designing steel frames as an end in themselves. They are part of the whole building which, with its floor and wall panels, exists in three dimensions—a very different structure from the two-dimensional frame, even when designed by the plastic theory. Just as we made a bold step in creative thought from the simple calculation of stresses in beams and columns to the consideration of the collapse of the complete two-dimensional frame, so we can step still further. Each such step, it is true, takes us away from simplicity. A multiplicity of unknown factors and variable conditions may be introduced to make the final solution difficult to reach, but complexity and efficiency often go together.

The first step in further development of creative thought in structural steelwork is probably to imagine even the simplest multi-bay, multi-storey steel frame as a three-dimensional entity rather than a series of two-dimensional frames linked together. Evidence of the saving in steel to be effected by work along these lines is given by the lightness of the frame used in the system devised by Dr. Klöttel. Before the war the Quarry Hill flats of Leeds were designed with this system and, more recently, the Hindhaugh Street flats built by the Corporation of Newcastle upon Tyne (Fig. 5) again show the lightness which is obtained when the steelwork of each floor is considered as a horizontal stiffening girder and the designer takes the step of thinking in three dimensions.

What, then, is the relationship between the collapse load of a bare frame and that of the building it supports? No one can give the complete answer, but Dr. R. H. Wood, of the Building Research Station, and his colleagues have been working steadily on a study of the strength of composite structures. Like the Steel Structures Research Committee, they have measured stresses in buildings under construction—notably the new Government buildings in Whitehall—and have confirmed what had long been suspected, that even light cladding of buildings stiffens them tremendously and that the true value of the strength of steel-framed structures will not be determined until we think both in three dimensions and in terms of the whole building rather than of its frame only. Beams built into completed buildings have been found, because of the stiffness of the cladding, to be stressed due to live load to only one-quarter-ton per square inch.[8] Not only are moments and stresses modified by the cladding and by the relative stiffnesses of the different units of the frame, but the very distribution of the loading depends upon these factors.[9]

We are at the stage now of being closer than ever before to a true understanding of the behaviour of steel frames.[7,9] The approaching publication of both the second volume of Professor Baker's book *The Steel Skeleton*, and of a National Building Studies Research Paper 'Studies in Composite Construction, Part 2',[10] point the way in which creative thinking is tending.

PART 2: Read by Mr. D. W. Cooper

Dr. Cassie has described the changing outlook of the structural engineer and something of the new concepts introduced by Professor Baker and by work at the Building Research Station. Coincident with this change in the technique of design there has been in progress a search for better ways of using known materials, and for improvements in those materials. Some of these developments have been borrowed from kindred engineering professions such as the automobile and aircraft industries. One might say we have gone so far as to borrow for this work the miracles of television—in the form of the oscillograph—and of cosmetics—in the form of 'brittle lacquers': both help to show us visually the workings within a material which are normally hidden.

Since the late war there has taken place increasing use and development of cold-formed sections. As the name implies these structural sections are fabricated from strip steel without the application of heat. The strip is supplied (from Margam) in rolls, usually in widths of 36 in., and perhaps weighing some 4 tons each. Machines at present in use handle strip up to 10 in. wide, and the first process of manufacture is to shear the material to required width, after which it is fed through successive rolls, each one impressing a little more of the required shape until, after the last, the required section emerges. The labour involved in setting up the mill varies from a few hours to several days depending upon the complexity of the shape required, and is therefore a decisive factor in determining the minimum economic run of section.

With processes such as these the designer has at his disposal an unlimited variety of shapes to apply to his requirements, and he may of course devise his own sections. As a result the weight of metal required to do a certain job is reduced very much below what can be achieved with hot rolled sections, particularly for small and medium spans. For spans of 25 to 50 ft. a saving in

weight of 50 to 60 per cent is claimed over that of conventional forms as delivered to site. In site handling of course the light-weight structure scores by saving up to 25 per cent of the cost in fixing trusses.

Some criticism has been directed at cold-formed sections because of their apparent vulnerability to corrosion and so it is of interest to note that trusses built from these sections and erected circa 1941, without any protection save a single coat of oxide paint, are still as good as ever. Independent tests in the U.S.A., in the atmosphere of Pittsburgh, have shown no worthwhile corrosive effect after 15 years. The normal treatment in this country is phosphatising by dipping followed by stoved painting. New material now becoming available is known as Cor-Ten, a rust-inhibiting steel having a strength some 25 per cent greater than that of the standard quality, and a fatigue resistance some 80 per cent greater.

For the architect the cold-formed section offers a clean external appearance ready for painting, and when used in schools and the like, it does not require casing. Fenestration can be secured directly to stanchions. (Fig. 6.) It is of particular interest that research on cold-formed sections has been carried out at the Royal Technical College, Glasgow, and at the University of Bristol.

Parallel with the development of cold-formed sections has grown the use of tubes, a form of construction already well known to the aircraft industry and latterly to the motor industry also. In contrast to the cold-formed sections the tube offers the designer only a choice of diameter and wall thickness, although a large number of both are produced, diameters ranging from 27/32 in. to 12¾ in., each one being available with six or seven wall thicknesses. The tube is well known for its high stiffness/weight ratio. As in the case of cold-formed sections most connections are made by welding, so that the frames so made gain not only by reason of their low self weight but also because of the tremendous stiffness resulting from the welding technique.

The assembly hall of an infants' school for the Essex County Council is supported on columns of welded tubes which are left exposed as a feature, and it is of interest to see the top of the column formed to a curve which accommodates a gutter bounding the roof. Dr. Cassie has mentioned the three-dimensional outlook, which after all is the natural medium of architects. Such three-dimensional or space frame conceptions are apparent in the design of a factory extension for J. H. Ballinger, which incorporates a roof constructed in bays 28 ft. by 60 ft. Both the roof and the glazing are carried on lattice girders which are triangulated as seen on plan, and an interesting detail is the way in which brackets are slung from the main girders to carry runway beams.

Yet another example of the three-dimensional approach is a shell roof built for Messrs. May & Baker at Dagenham. Probably the greatest drawback to shell construction is the high cost of shuttering but in this design developed by Ove Arup & Partners lattice girder units of tubular construction are employed as a 'membrane', over which a mesh reinforcement is placed, and covered by concrete. The tubular frame remains cast in the concrete.

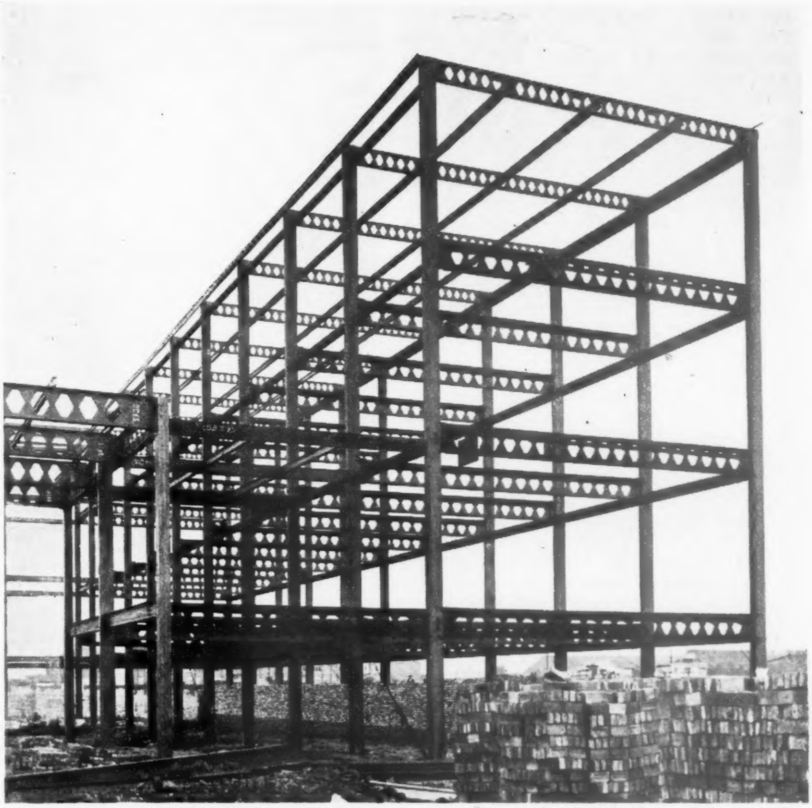


Fig. 8. Longlands County College, Middlesbrough. Architect: P. R. Middleton [*A*]. Structural Consultant: D. W. Cooper, B.Sc., A.M.I.Struct.E. Steelwork by United Steel Co. Clear spans using 'Castella' beams carried on box stanchions of welded channels.

The foregoing notes have probably given the impression that the hot-rolled sections we have come to know so well are now only museum specimens. Such is far from the truth, for the cold-formed sections and tubes possess an inherent economic disadvantage because of the extra work that must be employed to produce them and the more costly techniques of fabrication used upon them. It is therefore interesting to look last at our old friend the R.S.J. So far, ideas have been mentioned borrowed from the motor and aircraft industries, so it will hardly come as a surprise to know that from the shipbuilding world comes the idea of the castellated beam, originally the invention of Mr. G. M. Boyd. The successful application of flame cutting enables an ordinary R.S.J. to be cut along its web to a regular pattern. The upper and lower halves of the beam are then separated and re-welded so that a series of perforations is formed in the web. The result is a unit no heavier than the parent section but one and a half times as strong in bending and nearly twice as stiff. The latter characteristic may in practice be of greater import than the strength, for we are all well acquainted with the cost of these extra tons required only to limit deflections on long spans. To the architect is offered the possible use of exposed perforated webs as a feature of his building, and the undoubted advantages of being able to run services through the apertures provided (Fig. 8).

To demonstrate the earlier remarks on the three-dimensional approach in practice, together with the use of castellated sections, a factory frame is shown. This is being erected at Peterlee for North East Trading Estates Ltd., on a site which it is predicted will undergo considerable movement during the next few years. A minimum vertical movement of $\pm$ 18 in. accompanied by a horizontal movement of $\pm$ 12 in. is thought to be a likelihood, and the frame was designed to accommodate such movement without any change in stress and without fracture of glazing and the like. The main workshop area is 39,000 ft.^{2} and is covered by frames constructed and erected in independent strips, each having a clear span of 120 ft. (Figs. 9 and 10). From the outset architect and engineer worked in collaboration, so that the monitor roof required by the former was used to span a distance of 120 ft. as a simple space frame. The lower members of the frame are castellated sections which also carry the flat roof on each side. There are no purlins as such, for the roof sheets (Q-deck) span directly from one beam to

the next, a distance of approximately 8 ft. From the interior the roof space is quite unobstructed and enables a high uniform level of natural lighting to be obtained.

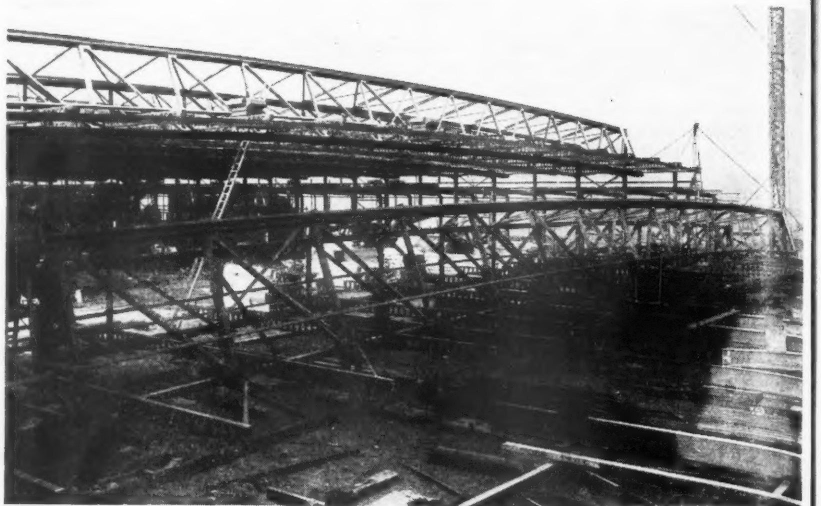
In constructing the frame we decided at the outset that each strip should be assembled at ground level and then lifted as a unit, each one representing 3000 ft.^{2} of roof area, and involving a lift of 14 tons (10·4 lb./ft.^{2}). At one end the unit rests on a stanchion group rigidly attached to it whilst at the other the stanchion group is freely hinged. The stanchion groups carry the wall panelling and windows, which move with them. The only brick wall in the building is set on a concrete kerb having a rounded base so that it too may follow movements of the frame without restraint.

We find, then, a change in two directions —first in the newer conceptions employed in determining the safe condition of loading for a building, and secondly in the use of new sections and new methods. Development is by no means complete, and the buildings already designed by the plastic design method and erected in cold-formed sections, in tubes, in castellated beams in three-dimensional construction, and in prestressed steelwork are indications of the amount of ingenuity and imagination which is being applied to that commonplace of modern architecture—the steel frame. Perhaps we may still be able to place it alongside the more flamboyant examples of the modern miracle, and claim for it a place as at least one of the minor wonders of the world?

DISCUSSION

Mr. George Fairweather [*F*]: One of the reasons why proposing this vote of thanks is to me a very formidable task is that my education in the subject of these papers comes from an age which is regarded by the authors as obsolete! I put that to you because I feel that I am bound to reveal my ignorance and ineptitude so far as this new science of engineering is concerned in the few words I might choose to say. Nevertheless as an architect I felt some encouragement from Professor Fisher Cassie's early remarks that ideas are probably more important than physical details. Coming from an engineer I thought that was most surprising information, and it suggested that something really good was coming, and I think that in fact Professor Fisher Cassie has shown us that ideas are indeed more important than physical details.

It has always been a bee in my bonnet so far as engineers are concerned that they are good at arithmetic and they manage to prepare some most elaborate calculations which produce a very definite answer, although not necessarily one which is attractive to the architect. But against that I have always been inclined to think that the most inaccurate assumptions are worked on. Professor Fisher Cassie did suggest that we could look at a building as a three-dimensional structure and that we did not have to break it up into bits and pieces and say that every piece was designed to support the maximum stress which might be encountered at any one time.



Figs. 9 and 10. Factory for Alexandre Ltd., Peterlee. Architect: J. H. Napper [*F*]. Consulting engineer: D. W. Cooper, B.Sc., A.M.I.Struct.E. A factory frame erected in unconnected strips, each spanning 120 ft. clear, and fully articulated to follow ground movements caused by mining. The upper photograph shows complete units assembled at ground level and lifted into position. The area covered by each unit is 3,000 sq. ft. and the time of lift is 90 minutes.

I suggest that the plastic design method which he has described departs from the criterion that at no point in a structure must the stress rise above a definite safe value. In other words, the criterion by which we design each member of the building so that it is within safe limits of design is now obsolete, and the new method relies on the principle that loads and forces are not, or need not be, entirely supported at any one point of a structure, and that it is therefore permissible to have stresses above the defined safe value at such points.

It appears also that the measure of stresses within the unsafe range that may be permissible can be ascertained by reference to the capacity of the structure as a whole to withstand occasional failure at points under localised stress. It is also suggested that failure by the development of up to four plastic hinges in a structure may occur before what is described as the true 'collapse load' is reached.

Is it to be understood therefore that the required strength or ultimate safe limits of stress at any point is not the stress that will cause failure at that point, but the stress that will produce a progression of stress failures up to the formation of, say, four plastic hinges? This assumption surely does not mean that the collapse of only one or two floors or columns in a building is

immaterial, but means that if the structure is designed by the plastic method, the strength of the building as a whole will ensure the strength of its separate parts.

As to how the engineer achieves such a magnificent result in design and can follow through the course of development of plastic failure in a structure and arrive at a point when fourth hinge failure is going to result in collapse is surely remarkable in engineering science. As an architect it is not necessary that I should understand how he does it, but I think it is necessary that I should know he can do that sort of thing.

Mr. Cooper did show us that modern techniques of fabrication can help a great deal towards refining designs, and he showed us how in our buildings we can achieve many delightful results by using some of the new cold processes of making steel components. There again I suggest that in the case of the civil engineer who is qualified and able to guide us in the use of those things we should be quite safe to work with him. Then Mr. Cooper shows us that we need not worry unduly about the fact that cold rolled steel sections are often unattractive to look at, very heavy and lead to uneconomic use. We can even do something to alter them if we dislike them.

What delighted me in Mr. Cooper's illustrations was the one showing the framework behind the shell roof. At first I thought that we were going to reach by the plastic design method the secret of the Lamella truss which I knew about as a boy. It may be that in suggesting engineers do not know the secrets of the Lamella truss I am out of date in contemporary knowledge.

The most fascinating part of Mr. Cooper's address concerned the experiment of Peterlee. With all due respect to the designers and architects of this remarkable work, I think that everyone associated with that design is hoping that the terrible conditions against which it was designed will never in fact occur. That may be because I am a conservative person and my ideas belong to a generation removed from that of our two very eminent speakers this evening.

Dr. H. G. Taylor, D.Sc.(Eng.), D.I.C., M.I.E.E., F.Inst.P., Director of Research, British Welding Research Association: Professor Fisher Cassie has rightly paid considerable attention to the work of Professor Baker and his team at Cambridge. This important work has been going on for at least eight years, and my Association have had the privilege of supporting it financially and in every other possible way for at least part of the time, and we are continuing to support it. I am very glad to say—and it is evident from the papers—that this research work is now bearing fruit. There are, I understand, no less than 18 buildings either completely constructed or in the course of construction using this method of design. Therefore I think that it may safely be said that we have reached a stage in this research at which Professor Baker has at least achieved part of his objective. He has introduced a method of design and it is in use, and we are greatly indebted to Professor Fisher Cassie and Mr. Cooper for bringing it to our attention in such an interesting and informative way.

They have presented their paper in the proper place for, after all, the contract for the business of erecting a building comes first to the architect. He designs it and he advises his client on the method of construction. Unless the architect is convinced of the wisdom of this method of constructing the very core of the building, then the client is not going to have an opportunity to say whether he likes it or not and the building will not be erected. Therefore it is appropriate that this new method should be displayed before this Institute. The architect's responsibility is to his client to see that he has the sort of building he wants, the services which he requires and that it is constructed in the cheapest possible way. One of the features of this method of design is that it enables one to economise in steel and erection cost; therefore the architect is doing the right thing in studying the method. Maybe he does not understand how the engineer arrives at it, but at least he uses the method and ensures that his client gets the right sort of building at the lowest cost.

I think that the three outstanding points which have been brought to our attention are plastic design, the use of cold formed sections, and the use of welding which has been mentioned so many times and which is essential to this plastic design method. We are indebted to the authors for bringing these facts to our notice and for doing so in such an interesting manner.

Mr. W. A. Allen [*A*]: I found it very interesting and rather unexpected to see the first comprehensive group of pictures of these buildings. If I understood Dr. Cassie correctly that is the case, and this is perhaps the first good collection of photographs of buildings under construction designed by this method. It is nice that it should happen in this Institute.

Assuming that we are at an early stage in the development, I do not know whether the tendency is towards greater complexity, but I should like to know whether it will add to the time and trouble so far as the design is concerned.

Mr. Cooper mentioned that cold rolled steel gave economies in weight of steel. Could he give us any typical figures of economies made over comparable sections?

Mr. A. B. Waters [*F*]: The question of cost is, I think, very important, but there is another aspect of steel design which we are all up against and that concerns building bye-laws. How far, for example, in a city such as London can steelwork be designed by the plastic method?

Mr. G. B. Oddie [*A*]: I should like to ask how the authors think the advantages of the plastic theory can be applied to those systems of steel frames which are being used to a wide extent in the field of what is commonly called prefabrication. The sort of thing I am thinking of is the Intergrid method which has been developed in prestressed concrete where there are a limited number of available components within the system for use in designing. I have the impression from the papers that the greatest advantage from the plastic theory was obtainable more or less in ad hoc cases rather than in buildings where there might be a variety of building with simple and standardised sets of components.

Also I should like to know how far the researches into the kind of space frames which Mr. Cooper showed us have been related to fabrication costs.

Mr. Raymond Walker [*L*]: I am a little worried about what will happen to a building designed by the plastic method in the event of a very bad fire. One feels it is a monolith depending not on simple articulation but on the elastic resilience of the material used. If that elasticity is going to be upset by the generation of heat in certain places, what effect will it have on the frame in other parts?

Mr. C. I. Berry [*A*]: Professor Fisher Cassie mentioned the interesting effect of cladding on the frame and the considerable stiffness which was derived from comparatively thin walls and infilled panels, and I should be grateful if he could state whether any more work has been done on that subject, and whether there is any information upon which we can draw.

Mr. Bednarczyk: I should like to know how this new system of design and the manufacture of cold rolled sections compare in constructional time, and whether they can be produced in quantity.

Professor Fisher Cassie: I should like to thank Mr. Fairweather and Dr. Taylor for their kind remarks. There is very little to answer in their comments except, I think, to talk about the way in which these buildings collapse. The point is not that the building itself, when it is under a working load, is in an imminent state of collapse. It is not. The stresses developed will probably be within the elastic limit, especially if the stanchions and beams and all other members are fairly uniform in section. It is fairly clear if we bring a uniform section up to the plastic limit it is taking a certain amount of moment, so if we have all these sections uniform we are more likely to get at the working load a stress which is not in the plastic state. In some tall buildings, such as five-storey buildings, probably the lowest stanchions are the important ones because the point which I have not brought out is that the vertical stress on the stanchions weakens and decreases the plastic moment which the stanchion can take, so we may find in taller buildings that the lower stanchions are more important than the others. If you wish to know more about this, written in a clear and effective manner, there is a publication by the British Constructional Steelwork Association—No. 5—which gives

a fairly clear picture of some of these methods of plastic design.

The British Welding Research Association has of course been in this business of plastic design from the start and has done a great deal not only in making experiments but in reporting the results of its researches. I have counted up the buildings which Dr. Taylor mentioned and I have found at least twenty-four. In the ARCHITECTURAL REVIEW of September 1954 you will find the Hunstanton School project which was designed by the plastic method and which used cold formed sections.

In reply to Mr. Allen, the design calculations are much simpler, therefore there is no additional cost in design time. The total cost of a structure designed by the plastic theory is not so easy to decide. In one instance the final figures worked out at 23 per cent less cost than by the conventional method.

Mr. Waters raised a point concerning building bye-laws and asked how far the plastic method might be used in London. In London you are required to put 2 in. of concrete around all steelwork, and he must work that one out himself!

Mr. Oddie asked whether the plastic design method could be used where a building consisted of simple components repeated in number. The answer is yes. That is where it would be of great value because we should then get these simple frames repeated indefinitely, requiring a good deal less steel and probably being cheaper in cost.

With regard to the question of fire, I do not think that there is any greater problem in this connection with the plastic design method. Steel when really heated can collapse and become plastic at the point where the fire impinges; but I do not think that there should be any more danger with a building designed by the plastic method. It is the same steel but simply a different method of using it.

On the question of composite structures, there is National Building Studies Technical Paper No. 13, 'Studies in Composite Structures Part I'. Part II is in the course of preparation and will be published shortly. The second part is Technical Paper No. 24, written by Dr. Wood of the Building Research Station.

Mr. D. W. Cooper: As far as the question of economics is concerned in connection with cold rolled steel sections, on the relatively few buildings which have been put up by that method the cost of the steel frame as it reaches the site is a little less at the moment than would be the cost of a hot rolled frame. Possibly 10 per cent would be the order of saving. Where the economies are effected is on site handling and erection, because one gets a roof truss or a beam roughly half the weight of its hot rolled counterpart; therefore, site handling becomes considerably cheaper. We must also remember that all these structures have to be carried on foundations, and the very light weight of steel frame which can be achieved by using the cold rolled system enables one to use much smaller concrete foundations, with further savings in excavation and material. In the fixing of the roof work there is a saving of 15 to 20 per cent over the traditional method and with stanchion work perhaps 10 to 15 per cent.

I should have mentioned that a plastic method of design may not be applied as yet to some of these materials which I have described to you, because the plastic method of design depends for its existence on a particular property of structural quality mild steel. If one is using a different material it is still possible to use the plastic theory of design but the peculiar quality is not there. On some of these sections the material may not be of the same quality as ordinary mild steel. We hope to get some steel shortly which is 50 per cent stronger than ordinary mild steel and rust inhibiting, which is important in this type of structure. It is called 'Corten'. As yet we have not been able to make anything from this material other than a few small parts.

I was asked to quote the weights in some of the space frames. The shell roof form of steel tubing weighs 4 lb. per sq. ft., and in the case of the school it weighs only $1 \cdot 7$ lb. per sq. ft. of floor area. Therefore by using the cold formed section or tube the total weight of material in a frame to carry a given load is much reduced, provided one is working on relatively small spans.

So far as fire risk is concerned, the examples of buildings in the North East were not encased because the bye-laws which apply in those areas are not the same as in London, and we are able to make the frame do its work without having to carry many tons of concrete which I regard as useless weight. Professor Fisher Cassie did draw attention to a possible solution, namely that if you are going to encase the steelwork in concrete then make the concrete do some of the load carrying.

I was asked about the quantity of material which can be produced by the cold rolling system and whether it is an economic proposition. The machines for it are complex and take a long time to set up. If you are proposing a simple form of section perhaps a few hours only will be required to set the machine. But if you require a complicated shape several days might be needed. The cost of setting up has to be allowed for in the production of the material, therefore in order to make it an economic proposition one has to run off perhaps 1,000 or 2,000 ft. before paying the cost of setting up the machine.

There is no limit to the quantity which may be produced. In fact, the firm which kindly supplied the photographs are exporting to California as much as 25 per cent of their production because they can produce and export more accurately and cheaply than the Americans.

Again on the question of protection against fire, the very act of building these frames having as many solid joints as possible does increase their safety factor against the action of fire.

The Chairman: One point to which I should like to draw attention is that I am sure architect members will agree with me that many of the illustrations shown by the authors this evening displayed an elegance and beauty which, after all, is something with which we as architects are concerned besides matters of cost, utility and fabrication.

Buildings known to the authors to have been designed by Baker's Plastic Design Method

Fourteen buildings erected, including
- Chatham Ship Fitting Shop
- Rosyth Gas Cylinder Store
- Ford Main Store

and three more contracts placed (Admiralty)
Abington Fatigue Laboratory (Atkins and Partners)
Research Laboratory for Guest Keen and Nettlefold (J. F. Baker)
Factory (Conder Eng. Co. Ltd.)
Warehouse (I.C.I. Paints Division, E. J. Callard)
Film Storage Building for Technicolor (R. T. James and Partners)
Hunstanton School (Ove Arup and Partners)
Transit Shed, Southampton, for British Transport Commission (Scott and Wilson, Kirkpatrick and Partners)
and several other buildings for the War Office, a Manchester firm, British Welding Research Association, etc.—all still on the drawing board.

Acknowledgments. The authors are grateful to the following persons and organisations for data, photographs and assistance: Admiralty, C. E.-in-C. (D. H. Little and P. W. Collins). C. W. Andrews, A.M.I.Struct.E. Ove Arup & Partners. Ayrshire Dockyard Co. Professor J. F. Baker, University of Cambridge. British Transport Commission (J. H. Jellett, Docks Engineer). Building Research Station (Dr. R. H. Wood). H. Connolly [F]. Guest Keen & Nettlefolds Group Services Ltd. (J. Lowndes). S. Henderson, B.Sc., King's College, University of Durham. R. T. James & Partners (M. L. Franks, M.I.C.E.). T. F. Lawson [A]. Lothian Structural Developments. May & Baker, Ltd. P. R. Middleton [A]. J. H. Napper [F]. City Architect's Department, Newcastle upon Tyne (E. Czeiler, M.I.Struct.E.). Palmers Hebburn Co. Ltd. Scaffolding (Great Britain) Ltd. Scott & Wilson, Kirkpatrick & Partners. J. Turnbull, King's College, Univ. of Durham. United Steel Co. Ltd. R. J. Wilkins, Department of Civil Engineering, University College, London. Mrs. Audrey Wilkinson-Cox.

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Internal Bathrooms and Water Closets with Natural Ventilation

By J. B. Dick, M.A., B.Sc., and G. D. Nash, Dip.T.P. [A]

Of the Building Research Station

IN BRITAIN, bathrooms and w.c.'s are usually provided with at least one external wall with a window for natural lighting and ventilation; if however they are planned as internal rooms and without roof lights a mechanical ventilation system is normally installed. It is perhaps not generally realised that natural ventilation may often be quite satisfactory for these internal rooms; this practice is accepted in certain European countries and a few examples exist in Britain, where interest in the subject is developing.

The new Model Byelaws of the Ministry of Housing and Local Government state that the ventilation of a w.c. shall be deemed satisfactory if at least three air changes per hour are given by mechanical or *other means*; no particular requirements have been stipulated for the ventilation of bathrooms except where gas water heaters are installed.

A mechanical system requires capital outlay, space for the plant, and maintenance. In large buildings like hotels and blocks of flats with mechanical systems, the responsibility for inspection can be given to a resident engineer as part of his routine duties, and a contract for regular maintenance by a specialist firm may be arranged. As architects and building owners are prepared to accept the plant and maintenance costs, internal bathrooms and w.c.'s must offer some compensating advantages; if however these internal rooms could be satisfactorily ventilated by natural means, they would no doubt be built more extensively.

This paper outlines advantages to be gained by the use of internal rooms, gives a design basis for natural ventilation and discusses various systems that may be used.

The initial benefit to be gained is a greater freedom and flexibility in the lay-out of rooms; bathrooms, shower cubicles and w.c.'s are comparatively small rooms and freedom from the necessity to provide them with external wall space will often assist the architect to attain a compact and economical plan. The R.I.B.A. memorandum to the Bailey Committee on the 'Quicker completion of house interiors' stated: 'We agree that simplification of the various interior fittings is desirable, but would emphasise that much more flexibility in planning is required if economy is to be achieved.' The Committee's report illustrates several plans of flats or maisonettes with internal w.c.'s ventilated to the outside by vertical ducts to the roof.

With internal bathrooms and w.c.'s, greater use may be made of the external walling for window space to the living- and bedrooms. Alternatively, for any particular size of flat a smaller external wall area may be possible; the narrow-fronted dwelling, whether a flat, maisonette or terrace house, will be easier to plan. Economy of frontage is important also in achieving economy in estate lay-out by reducing length of roads and main services. Small windows, normally associated with bathrooms and w.c.'s, are often a complication in architectural design and from this aspect freedom to dispense with them is an added benefit.

Advantages from the use of internal rooms are not limited to new buildings. The improvement or conversion of existing dwellings, many of which are in terraces and have comparatively narrow frontages, may offer considerable opportunities for the advantageous use of these internal rooms.

With internal rooms, the provision of internal plumbing ducts becomes a necessity; these occupy a comparatively small floor area and particularly with repetitive floor plans in multi-storey buildings they should present no serious difficulty in planning. They are not a new feature to the British architect; they avoid the use of unsightly external plumbing, practically eliminate the risk of freezing in the pipes and encourage compact lay-out of sanitary fittings and plumbing.

Plans of flats and maisonettes, prepared by the Ministry of Housing and Local Government, are illustrated here; those with bathrooms and w.c.'s on outside walls are compared with others of similar accommodation but having internal bathrooms and w.c.'s. These comparisons, given in Tables I and II for flats and maisonettes respectively, show clearly the economy of frontage which is obtained in those plans with internal bathrooms and w.c.'s.

Basis for Design of a Natural Ventilation System. Natural ventilation results from pressure created either by wind or by a difference in temperature between the inside and outside of a building (in the latter case it is usually referred to as stack pressure). The rate of ventilation in a system designed to utilise wind pressure only will be proportional to the wind speed; in a system based solely on stack pressure the rate will be proportional to the square root of the temperature difference. Changing weather conditions will cause considerable variations in ventilation rates; as on occasions the ventilation rate may be low, systems should be designed so that air change rates lower than a stipulated rate do not occur frequently. The average air change rate produced will then be well above the stipulated rate.

To satisfy the standard of the model byelaws, a mechanical ventilation system could be installed to give three air changes per hour continuously in an internal room: this

Table I. Comparison between flats with bathroom and w.c. on outside wall and flats with internal bathroom and w.c. (areas in sq. ft.)

Description	4-person flats			
	Frontage	Total area of habitable rooms and kitchen	Total area of living room and kitchen	Area of flat
Plan No. 1	29 ft. $8\frac{1}{2}$ in.	544	290	701
Plan No. 2	29 ft. $2\frac{1}{2}$ in.	521	266	665
Plan No. 3	25 ft. $1\frac{1}{2}$ in.	536	288	692
Plan No. 4	25 ft. $1\frac{1}{2}$ in.	537	289	657
	5-person flats			
Plan No. 1	35 ft. 8 in.	672	333	850
Plan No. 2	33 ft. $8\frac{1}{2}$ in.	608	280	787
Plan No. 3	25 ft. $1\frac{1}{2}$ in.	597	288	770
Plan No. 4	25 ft. $1\frac{1}{2}$ in.	597	289	750

NOTE: Plans Nos. 3 and 4 have internal bathrooms and w.c.'s.

Table II. Comparison between maisonettes with bathroom and w.c. on outside wall and maisonettes with internal bathroom and w.c. (areas in sq. ft.)

Description	4-person maisonettes			
	Frontage	Total area of habitable rooms and kitchen	Total area of living room and kitchen	Area of maisonette
Plan No. 5	17 ft. 5 in.	527	264	749
Plan No. 6	14 ft. 3 in.	517	265	683
Plan No. 7	14 ft. 3 in.	530	273	681

NOTE: Plans Nos. 6 and 7 have internal bathrooms and w.c.'s.

rate would not remove all traces of odour or water vapour instantly but is a reasonable standard to achieve. If a natural system is designed so that the air change rate drops below the specified three air changes per hour for only a small percentage of the time, such a system will during those periods be less satisfactory than the mechanical system with its constant ventilation rate. At other times the natural system will provide a higher air change rate; its average rate will be higher than that of the mechanical system. For instance, if a natural system is designed to operate on wind pressure and to give a rate of at least three air changes per hour for 80 per cent of the time, it will provide an average rate of about seven air changes per hour. Thus the use of a natural ventilation system implies acceptance for a small percentage of the time of a rate below the stipulated level.

Ultimately, the occupant of the dwelling must judge the suitability of such natural ventilation systems, but at present there is little experience of these systems in this country. On the Continent, where experience is more extensive and showers are often provided instead of baths, it is accepted that natural ventilation can provide a satisfactory service. Assuming that the continental standard of judgment is acceptable in this country, then the systems in general use will serve as a check for any particular design basis.

The ventilation rate in a system based on stack pressure will be low at those times when outdoor and indoor temperatures are nearly equal. This occurs on warm summer afternoons, but on these occasions windows in dwellings are generally open and an afternoon breeze creates general ventilation throughout the dwelling. At these times low rates in internal rooms will be less likely to cause annoyance than when the ventilation rate to the dwelling is low; the ventilation of the internal room may be assisted at such times if a well-designed terminal is fitted to the outlet of the vertical duct to utilise the suction effect of the wind.

With a system based solely on wind (i.e. with horizontal ducts), low ventilation rates will occur at periods of calm, e.g. during summer nights and winter fogs. Any temperature difference between the inside and outside air will however cause some circulation of air in the horizontal ducts and provide some ventilation by the stack pressure.

Bearing these factors in mind, it appears reasonable to design a natural system to give a minimum of three air changes per hour for at least 80 per cent of the time. For a system working on stack pressure this design basis should be applied to the summer period when failure can occur; with a system working on wind pressure, the distribution of wind speed throughout the year should be used. On this basis it is shown in the Appendix that for a stack pressure system the design temperature difference should be 2° F, and for a wind pressure system the design wind speed should be 2·2, 1·5 and 0·7 m.p.h. for exposed, suburban and built-up areas respectively; from these design values the sizes of ducts required to provide a given rate of air flow through an internal room for 80 per cent of the time can be calculated. Where these calculated values can be compared with duct sizes used in similar systems on the Continent it has been found that little difference occurs. The design can therefore be applied with some confidence for systems not at present in use on the Continent. In using continental experience in this way it must be remembered that the ventilation standard desired in this country is not necessarily the same as that accepted on the Continent: for this reason it is suggested that the sizes of ducts obtained from the above design basis be regarded as minima and that where convenient rather larger ducts should be used until experience in this country has been obtained.

A form of control is desirable for occasions when excessive ventilation may occur; such a control may be provided by an adjustable damper at the entry to or in one of the ducts.

The design data in this note are given on the assumption that no flueless gas appliances are to be used in the internal rooms. Where such appliances are to be fitted, special consideration of the ventilation system may be necessary.

Natural Ventilation Systems for Internal Rooms. A system may be designed with horizontal ducts primarily for wind pressure, with vertical ducts for stack pressure or with a combination of both.

With a horizontal system the direction of air flow through the ducts will tend to be the same as that of the wind; with a vertical system the direction of flow will be upwards for the greater part of the year as the inside temperature is normally higher than that outside, except during hot days in the summer. The systems should therefore be designed to suit the main direction of air flow with provision for both inlets and outlets. When the flow direction changes, the functioning of the inlets and outlets will be temporarily reversed. For this reason it is preferable that the designed inlet should be a duct leading from the outside air to the ventilated room rather than an opening from an adjoining room or lobby, so that when change of direction occurs the outgoing air will flow from the internal room direct to the external air, assuming the door of the room to be closed and reasonably airtight.

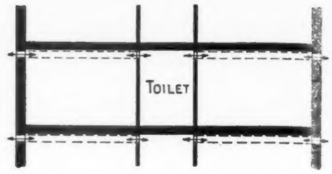


Fig. 1

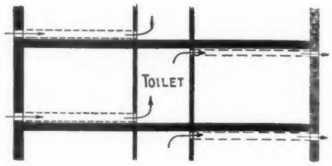


Fig. 2

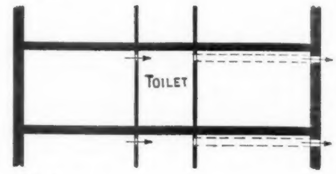


Fig. 3

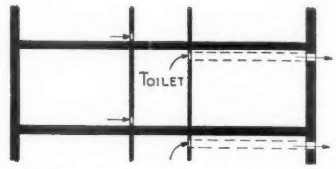


Fig. 4

Figs. 1 to 4 show horizontal duct systems. Arrows indicate the predominant direction of air flow on which the design is based

Figs. 1 and 2 show two simple systems with horizontal ducts designed to function under wind pressure, the inlets and outlets terminating on opposite sides of the buildings. In both systems the air can flow in either direction as dictated by the wind pressure; when both ducts serving a room are at the same level they should be placed near the ceiling. In Fig. 2 the room is provided with a high and low level duct to gain some advantage from stack pressure; in this system the high level duct should

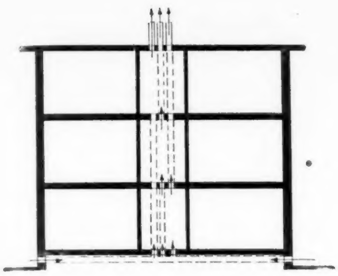


Fig. 5

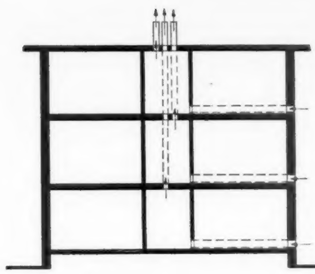


Fig. 6

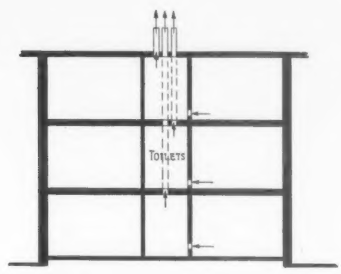


Fig. 7

Figs. 5, 6 and 7 show vertical duct systems with some horizontal ducts to serve as design inlets. Arrows indicate the predominant direction of air flow on which the design is based

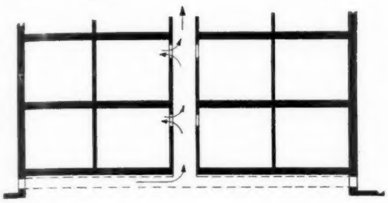


Fig. 8

Fig. 8 shows the common duct or shaft system. Arrows indicate the upward direction of air flow and the possible interaction between different floors of the building

be regarded as the outlet and should therefore terminate on the prevailing leeward side of the building. A low level duct will not always be desirable if it occupies useful floor space but it may sometimes be possible to incorporate it in the thickness of a floor or partition.

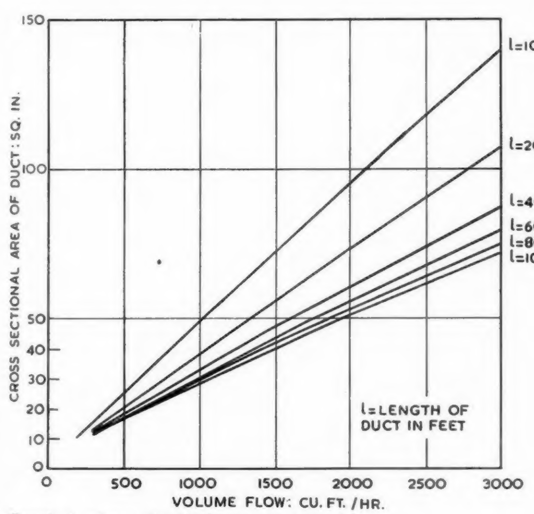
Fig. 5 shows a system with vertical ducts designed to function under stack pressure, the inlet and outlet apertures to each room being at floor and ceiling level respectively; a horizontal cross duct is provided at the bottom of the building to feed the inlet ducts. Assistance to the ventilation may be gained from wind pressures by fitting a suitable terminal at the top of each outlet duct. Change of direction of air flow through the ducts is likely to occur on hot summer afternoons; this should not be of any consequence provided the room door is kept closed to prevent leakage of foul air into an adjoining room or lobby.

In 1951 preliminary information was published on a new German standard specification, 'Ventilation of Internal Sanitary Rooms,' based on experimental work at Stuttgart. The specification required a system similar to that shown in Fig. 5, the sizes of ducts to be as follows:—

(1) Cross sectional area of the horizontal duct to be 80 per cent of the sum of the areas of the vertical inlet (or outlet) ducts.

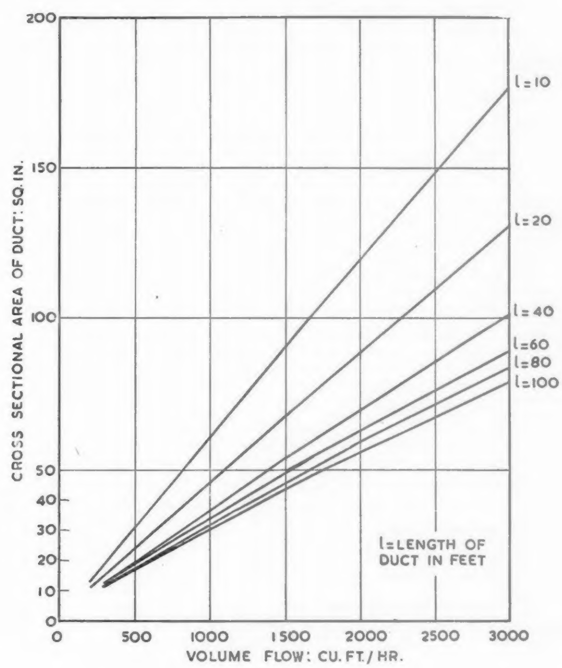
(2) Cross sectional area of each vertical duct to be (*a*) with smooth surfaces (e.g. asbestos cement, glazed stoneware), 16 sq. in. (*b*) with rough surfaces (e.g. fine concrete), 23 sq. in. (*c*) with rough surfaces (e.g. brick with pointed joints), 39 sq. in.

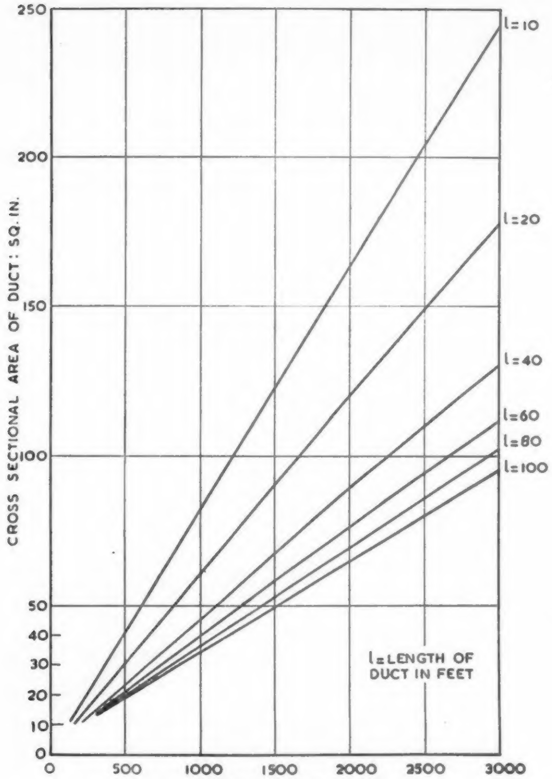
It is understood that the system was efficient and satisfactory in practice, but for the German social housing programme the cost of providing the ductwork was considered too expensive and simpler solutions have since been sought. Fig. 6 shows another possible development of a predominantly vertical system, the inlet in this case being provided by a horizontal duct.



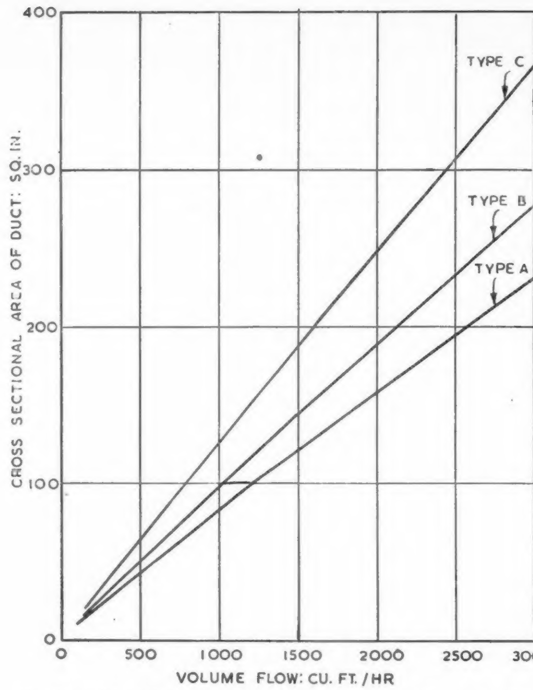
Graph 1, above. Vertical systems, type A

Graph 2, right. Vertical systems, type B





Graph 3. Vertical systems, type C



Graph 4. Horizontal systems in built-up areas, types A, B and C. It is assumed that the combined length of the inlet and the outlet duct will not exceed 40 ft.

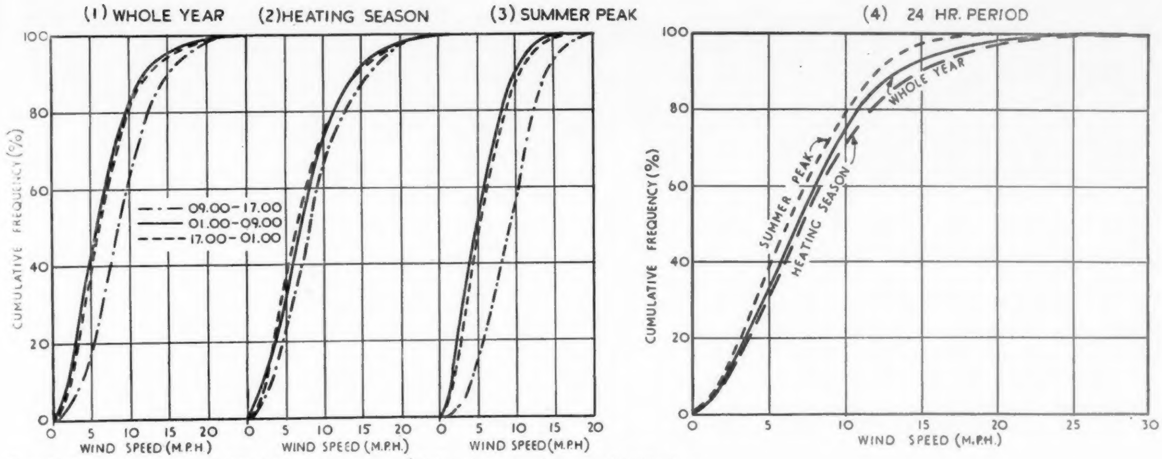
The above systems, with both inlet and outlet ducts to each internal room, can operate without interaction with the air in the remainder of the dwelling even when reversal of air flow occurs. With bathrooms and w.c.'s ventilated by windows on external walls, wind pressure sometimes forces foul air from these rooms into adjacent parts of the dwelling; if such reversals are also to be accepted with internal rooms, it will then be possible to dispense with the inlet duct and replace it by an opening between the internal room and the adjoining room or lobby. It is probably more satisfactory to do this in conjunction with vertical duct systems, as reversal of air flow will occur on relatively few occasions; with a horizontal system, reversal can be more frequent (replacement of the inlet duct by an inlet aperture with horizontal systems is shown in Figs. 3 and 4).

The vertical system with an inlet aperture to the room as shown in Fig. 7 has, in fact, been used in Denmark with vertical outlet ducts of 16 sq. in. area, the inlet to the room being a gap 1 in. wide at the base of the door. Dutch regulations accept a similar system, with a vertical duct of 5 in. or 6 in. diameter for smooth or rough internal surface respectively and with an inlet aperture of at least 4 in. diameter. These simpler vertical systems have apparently proved satisfactory in Denmark and Holland.

As regards building costs, a vertical system with individual outlet ducts from each internal room increases in cost per ventilated room as the height of the building increases and the ducts lengthen. In addition, the floor space occupied by the ducts increases with the number of storeys in the building. From this aspect, the next step in development of the vertical system is to use one duct to serve a number of rooms. Fig. 8 illustrates this system, which has been used to some extent in Belgium, with a common duct rather similar to a small light well and with a horizontal duct at the base to serve as an inlet. Similar systems with refinements have also been used recently in other European countries but the common duct has been comparatively small in cross sectional area and short secondary ducts have been used to link each internal room with the common duct. With such systems, direct air-to-air connection exists between the different floors in a building and precautions may be necessary to eliminate undue sound transmission and to minimise fire hazard. Foul air may pass from one internal room to another, particularly at times when a change of flow direction occurs. This interaction between rooms of different dwellings may well be less acceptable than interaction which may occur in the previous systems having separate ducts for each internal room; in the latter cases, the interaction is with an adjacent room or lobby and is not likely to affect other dwellings in the building.

Common ducts are, of course, used with mechanical systems but the extract fan provides at all times a controlled positive pull which is able to cope with any normal counteracting influences. With present knowledge, a common duct system for natural ventilation cannot be recommended for this country with an assurance that no serious complaints will arise; the system merits development and trial, as it may offer economic advantages, particularly for high buildings.

Another system which has been used consists of a large single horizontal duct at ceiling level in each internal room with no other provision for inlet to the internal room. In such a system, air change may be caused by pressure fluctuations due to wind turbulence and also by re-circulation due to temperature difference between the air inside and outside the building. One example of this system is known to exist in a block of flats in England and is reported to work satisfactorily; each internal room, a combined bathroom and w.c., has a duct about 10 ft. long and 2 ft. by 1½ ft. in cross sectional area. This duct is much larger than those used in the other systems where ventilation is more positive. A small lobby separates each internal room from adjacent rooms and is connected to the horizontal vent duct.



Graph 5 (*a*) above, and 5 (*b*) right. Frequency distribution of wind speed with time

Sizes of Ducts. A method of calculating the sizes of ducts required to provide a given rate of air flow through an internal room for at least 80 per cent of the time is outlined in the Appendix. The sizes obtained with these calculations are for ducts which are either square or circular in section. For the benefit of the building designer, the method has been used to prepare a set of graphs for determining the minimum cross sectional areas of ducts for the horizontal or vertical systems shown in Figs. 1 to 7 inclusive. It is not yet possible to provide a design basis for common duct systems as shown in Fig. 8 nor for systems in which a single duct only is provided for each internal room to act as both inlet and outlet.

The graphs show allowances for possible air flow resistance due to grilles, etc., at the ends of the ducts. The free area of grilles should preferably never be less than 70 per cent of the duct area. Three cases have been considered and are given in the graphs as follows:—

Type A—When inlet and outlet ducts are provided but no appreciable resistance is introduced at any end of the ducts (graphs 1 and 4);

Type B—When an inlet is provided in the door or walls of the room and the outlet duct has one grille, the free area of this grille and of the inlet being each equal to 70 per cent of the cross sectional area of the duct (graphs 2 and 4); and

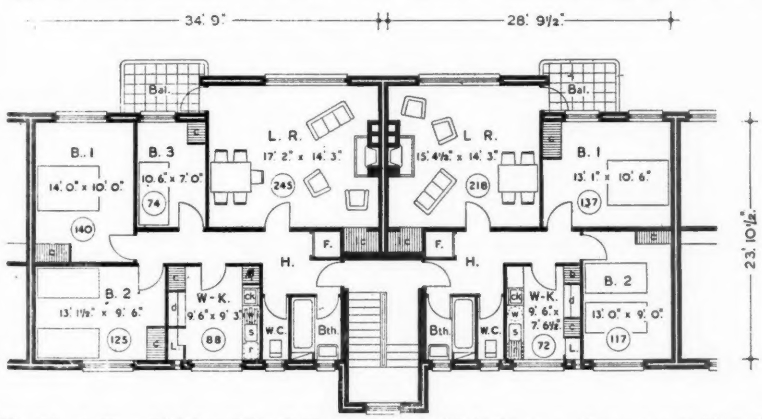
Type C—When inlet and outlet ducts are provided and are fitted with grilles at each end, the free area of each grille being 70 per cent of the cross sectional area of the duct (graphs 3 and 4).

Graph 4 gives the areas of ducts required for a horizontal system in a built-up area. It is assumed that the ducts terminate on open sides of the building, as, for example, the side facing a street rather than a side facing a courtyard where wind pressure would be much less effective. The procedure is to enter the graph for the appropriate type at the design rate of volume flow (equivalent to three air changes per hour) and read off the required area of the duct.

Graph 4 can be used for horizontal systems in (i) suburban areas by entering the graph at one-half the design rate of volume flow, and (ii) exposed areas by entering the graph at one-third of the design rate of volume flow.

Graphs 1 to 3 give the areas of ducts required for vertical systems. In these cases, the acting pressure depends on the length of the duct, and the graphs have been prepared for ducts ranging from 10 ft. to 100 ft. in length. The lower limit of 10 ft. has been chosen on the assumption that the ventilation of internal rooms on the top storey of a building would normally be provided by a roof light.

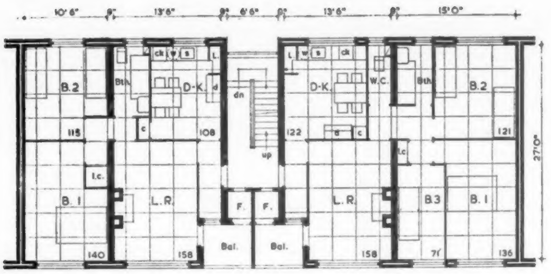
As an example, consider the ventilation of an internal bathroom with a volume of 500 cu. ft. in a building in a suburban area. The design rate of volume flow for three air changes per hour will be 1,500 cu. ft. per hour. Since the building is in a suburban area the size of ducts for a horizontal system will be obtained by entering Graph 4 at half the design rate of volume flow, i.e. 750 cu. ft. per hour. Assuming a type C system (as above), the area required for the ducts will be obtained from the appropriate graph line. Thus, reading at 750 cu. ft. per hour, the area required for the ducts will be 95 sq. in. Alternatively, the size of ducts required for a vertical system of type C can be obtained from Graph 3 by entering the graph at 1,500 cu. ft. per hour. With a vertical system it might be proposed to provide an inlet to the room from an adjacent room or lobby rather than by means of a duct from outside: this would provide a type B vertical system. Entering Graph 2 at the design rate of flow of 1,500 cu. ft. per hour would then give a duct area of 60 sq. in. for a vertical duct 40 ft. long.



Plan No. 1. Four (right) and five (left) person flats with bathroom and w.c. on outside wall. (From *Housing Manual*, 1949, Figs. 65 and 66, p. 88)

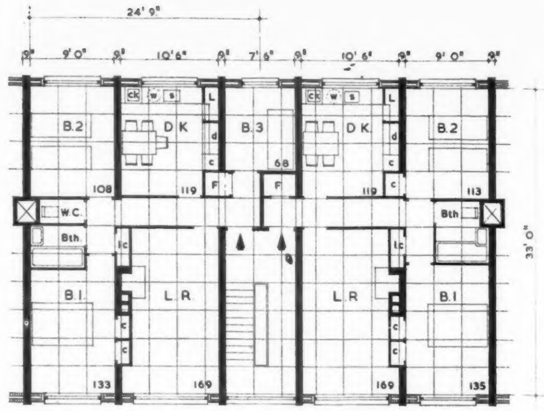
Conclusion. Internal bathrooms and w.c.'s are built on the Continent, in America and in Britain. They offer advantages in planning, and subject to adequate ventilation they appear to be acceptable in practice. A mechanical system of ventilation is normally provided in Britain to give the required ventilation. Natural ventilation with a separate duct for each room is considered satisfactory in certain continental countries and has been used in Britain.

With natural ventilation it is preferable that each internal room should be served by both an inlet and an outlet duct communicating with the external air. Omission



4 PERSON FLAT   5 PERSON FLAT

Plan No. 2, above. Four and five person flats with bathroom and w.c. on outside wall (From *Quicker Completion of House Interiors*, 1953, Fig. 32, p. 29)



5 PERSON FLAT (5 ROOMS) FLOOR AREA 770 SQ. FT   4 PERSON FLAT (4 ROOMS) FLOOR AREA 692 SQ. FT

Plan No. 3, right. Four and five person flats with internal bathroom and w.c. (Prepared by M. of H. and L.G. for Building Trades Exhibition 1953)

of the inlet duct is desirable for building economy and is accepted in Holland and Denmark. Risk of foul air from the internal room entering an adjacent room or lobby is increased if no separate inlet duct is provided; but this is not thought to be a serious objection to the system, as in practice the risk may be no greater than with a w.c. having an external wall and window.

A natural system with a vertical outlet duct will provide, for most of the year, an adequate and more uniform rate of ventilation than one with a horizontal outlet duct.

Apart from considerations of ventilation efficiency, choice between a horizontal and a vertical system on economic grounds will be influenced by the width and height of the building, as these dimensions will determine the length of ducts required.

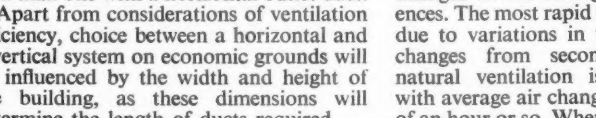
The duct areas given in the paper should be regarded as minimum sizes and should be increased if convenient until further experience has been obtained. Undue restriction of the air flow by registers of small free area, by bends in the ducts or by abnormal roughness of the ducts should be avoided. A control such as an adjustable damper may be desirable to restrict excessive ventilation.

Finally, the reactions of occupants must be considered before natural ventilation for internal rooms is accepted generally.

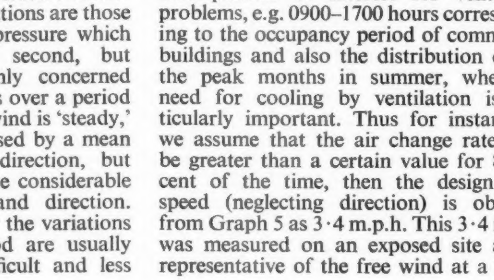
APPENDIX

Design Wind Speed. The rate of air change due to a natural ventilation system is continuously varying as it follows the alterations in wind speed and direction or changes in the acting temperature differences. The most rapid fluctuations are those due to variations in wind pressure which changes from second to second, but natural ventilation is mainly concerned with average air change rates over a period of an hour or so. When the wind is 'steady,' each hour can be characterised by a mean wind speed and a mean direction, but within the hour there will be considerable variation of both speed and direction. When the wind speed is low the variations in direction within a period are usually greater and it is more difficult and less appropriate to assess a mean direction (this excludes the case of local winds such as katabatic winds). It is possible, however, to assess a mean wind speed which can be related to ventilation rates.

With this in mind, data of hourly wind speeds as measured by the cup anemometer at Abbots Langley, Hertfordshire, have been analysed and Graph 5 enables the percentage of the hours when the wind speed is greater than any given value to be assessed. The data were analysed for the whole year and were also broken down into periods of interest for ventilation problems, e.g. 0900–1700 hours corresponding to the occupancy period of commercial buildings and also the distribution during the peak months in summer, when the need for cooling by ventilation is particularly important. Thus for instance, if we assume that the air change rate must be greater than a certain value for 80 per cent of the time, then the design wind speed (neglecting direction) is obtained from Graph 5 as 3·4 m.p.h. This 3·4 m.p.h. was measured on an exposed site and is representative of the free wind at a height



5 PERSON FLAT (5 ROOMS) FLOOR AREA 750 SQ. FT.   4 PERSON FLAT (4 ROOMS) FLOOR AREA 657 SQ. FT.

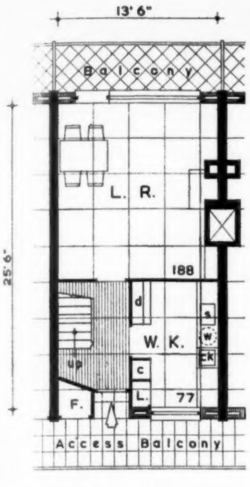


LOWER FLOOR   UPPER FLOOR

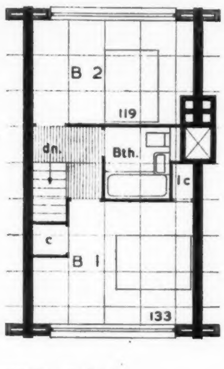
Plan No. 5, above. Four person maisonette with bathroom and w.c. on outside wall (From *Housing Manual*, 1949, Fig. 72, p. 91)

Plan No. 4, left. Four and five person flats with internal bathroom and w.c. (Prepared by M. of H. and L.G. for Building Trades Exhibition 1953)

Plan No. 6. Four person maisonette with internal bathroom and w.c. (Prepared by M. of H. and L.G. for Building Trades Exhibition 1953)

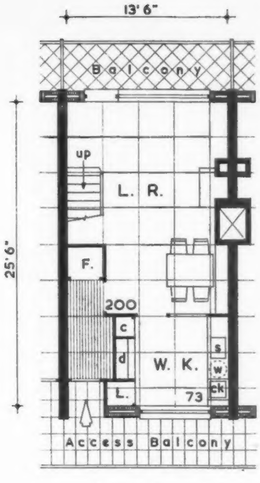


LOWER FLOOR

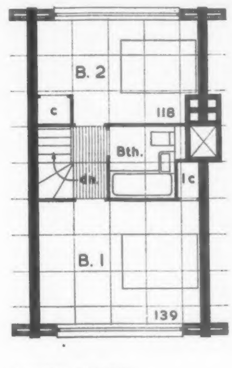


UPPER FLOOR

Plan No. 7. Four person maisonette with internal bathroom and w.c. (Prepared by M. of H. and L.G. for Building Trades Exhibition 1953)



LOWER FLOOR



UPPER FLOOR

of about 30 ft.; in suburban and built-up areas where there is sheltering by adjacent buildings the effective wind speed is reduced, and although there is obviously a wide range of local conditions it is thought that typical reductions in the effective wind speeds can be taken as $\frac{1}{3}$ and $\frac{2}{3}$ for the suburban and built-up areas respectively. Thus the design wind speed would drop from 3·4 to 2·3 m.p.h. for a suburban area and to 1·1 m.p.h. for a built-up area. Other design speeds can be readily obtained from the graph for any other desired levels of probability.

So far the effect of changes of wind direction has not been considered. As stated earlier, with low wind speeds large fluctuations in direction tend to occur and it is difficult to assess a mean direction which has a significance in ventilation. It is reasonable to assume that all directions are equally probable within an hour; if the effective wind speed is taken as proportional to the cosine of the angle that the direction makes with the normal to a building, the average effective wind speed will be the average wind speed times the average value of the cosine between 0 and 90°, i.e. 0·64 times the average wind speed. Thus the above figures of 3·4, 2·3, 1·1 m.p.h., which are based on the free wind speed, will correspond to effective wind speeds of 2·2, 1·5, 0·7 m.p.h. respectively. It is therefore suggested that the latter figures should be used for the design of systems based on the utilisation of wind pressures.

Table III. Duration of inadequate ventilation (hr./day)

Solar gain (°F)	Design temperature difference (°F)			
	1	2	3	4
0	1·6	3·2	4·8	6·4
2	1·6	3·2	4·8	6·6
4	1·6	3·4	5·2	7·2
6	2·0	4·0	6·2	10·4
8	2·6	7·0	8·0	8·8
10	3·4	4·8	6·0	7·0

NOTE: The amplitude of external air variation is assumed to be 10° F.

Design Temperature Difference. In considering the temperature differences which can produce ventilation by stack effect two components need to be assessed, viz. the steady temperature excess during a day and the alternating component in which the temperature of the internal air attempts to follow the fluctuations of the external air temperature. In winter the temperature differences will be large and there is little difficulty in providing satisfactory ventilation; in summer, however, there will be periods when the difference between the internal and external temperatures will be small and ventilation rates will decrease. In summer the mean internal temperature will be above the external temperature by an extent depending mainly on the gain from solar heat, cooking, etc.; it will also be affected by the ventilation due to windows. The alternating component inside will usually be much less than that of the external air temperature and will depend on the thermal capacity of the building and on the ventilation rate; a typical value for the alternating component in an inner room might be about 3° F for a 10° F amplitude in the external temperature. It is difficult to be precise regarding the value of the internal temperature; an indication of its effect can be obtained by considering particular cases. For instance, in a very heavy building the temperature of an internal room could remain substantially constant throughout the day at a few degrees above the mean external air temperature. On this assumption, the duration of the period of unsatisfactory ventilation can be evaluated for given design temperature differences in terms of the mean excess internal temperature due to solar gain; results are given in Table III.

The small alternating component which can occur in an internal room is unlikely to affect greatly the duration of inadequate ventilation, so that the table can be taken to indicate conditions if the building has a high thermal capacity (which is usually the case) and if it is assumed that the maximum internal temperature will be less than the maximum external temperature, so that for a period reversal of air flow occurs. It is proposed that the table be used for design purposes; thus if the ventilation is to be satisfactory for 80 per cent of the time in summer, a design temperature difference of about 2° F could be used. This criterion implies that throughout the year the ventilation will be adequate for about 90 per cent of the time as compared with the 80 per cent used in assessing a design wind speed; both systems will give satisfactory ventilation for 80 per cent of the time in summer. Thus a system based on stack effect with a temperature difference of 2° F will provide high rates of ventilation during the winter; the ventilation will be inadequate for a few hours on summer afternoons but this will be followed by increased ventilation at night. A system based on the suggested design wind speed will give satisfactory ventilation for about 80 per cent of the time; the periods of failure will occur partly with the low wind speeds on summer nights, the remainder being equally probable throughout the year.

To summarise, it appears reasonable to take design wind speeds of 2·2, 1·5 and 0·7 m.p.h. for exposed, suburban and built-up areas respectively and a design temperature difference of 2° F.

Comparison of Wind and Stack Pressure at the Design Values. It is of interest at this stage to compare the magnitudes of the pressures that are available for ventilation when wind and temperature difference have the design values suggested above. The wind pressure is given by:

$W = 0{\cdot}00051v^2$ where W = wind pressure (inches water gauge), and v = wind speed (m.p.h.)

and stack pressure from the relationship:

$S = 2{\cdot}8 \times 10^{-5}$ h.T. where S = stack pressure (in. w.g.), h = effective height between inlet and outlet (ft.), and T = temperature difference (°F).

The two pressures are equal when

$$18v^2 = h.T.$$

Substituting the design values of 2·2, 1·5 and 0·7 m.p.h. and 2° F it is found that stack effect will predominate when the effective height is greater than 44 ft. in an exposed area, 20 ft. in a suburban area, and 5 ft. in a built-up area.

Estimation of Duct Sizes. Having decided on the design pressures, the sizes of ducts required to carry the standard ventilation rate can be calculated. With an open-ended duct there will be a loss of ½ velocity head at the inlet and 1 velocity head at the outlet. If the duct has a grille, the free area of which is 70 per cent of the area of the duct, there will be a loss of 2 velocity heads at the inlet and 3 velocity heads at the outlet. Thus systems types A, B and C described previously will involve total losses of 3, 5 and 10 velocity heads respectively. Allowance must also be made for the frictional resistance of the ducts; with turbulent flow in a rough brick or concrete duct this will involve the loss of one velocity head for a length of duct equal to 23 times the diameter. Thus equating the design pressure to the pressure loss in the system, which will vary according to the type of system, the relationship between the design rate of volume flow and the area of duct required can be determined.

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Modular Co-ordination Research: The Evolving Pattern*

By W. A. Allen [*A*], Superintending Architect, Building Research Station

EDITOR'S NOTE: This paper, presented to the Modular Society, describes the work on modular co-ordination now being done by the Building Research Station. It is a counterpart to the paper by Mr. Bruce Martin [A], published in the January JOURNAL, *which described the work on this subject being done at the British Standards Institution.*

IN THE OPENING SECTION of his paper Mr. Allen said that they were treating the study as a straightforward research and development programme. Observation and study of facts came first, from which they would try to infer some law, principle or hypothesis. Experimental proofs to establish the validity of the hypothesis would then be sought. All this would provide a sound starting point for development work.

In the observation stage they were investigating modules already in use and the dimensions of standardised products. In the hypothesis stage, the focal point of the problem, they were thinking in terms of a group of related dimensions or 'number pattern', after which they would experiment to see how far it met practical demands of all kinds. He emphasised that they were aiming at a simplified pattern of dimensions to serve the *whole* industry, both wet and dry. Trying to serve a part only risked raising barriers to the natural development of building practice. Also, such a dimensional pattern must be fundamentally sound. This was why they were proceeding in a scientific manner though some people might think it slow.

Reviewing Experience. It was agreed, as Martin said in his paper, that initially his group at B.S.I. would concentrate on the dimensions of building products, while we at the Station would give our attention to a review of experience in the field. This, of course, was all part of the work which is done in preparation for the 'hypothesis' in a research, but the study of experience had another special purpose, for we wanted to discover as far as we could what exact kinds of advantages, and for whom, were provided by modular co-ordination. The point is that it must benefit the architect, the builder, and the manufacturer, and must not only do so, but do it in an obvious way and to an appreciable extent, or any one of these three could hold up application by failing to have any interest in it. To some extent this applies to the client also. Therefore it is important to know exactly what kinds of benefit each had found already so that later one could see how to improve upon these in application and development.

British experience of modular working lies almost entirely in prefabrication, mostly for schools but partly for housing, to the extent of some £30–£40 m. annually in completed buildings. Outside this there are various supplementary kinds of dry construction, mostly curtain walls, partitions and suspended ceilings, which struggle to find a dimensional 'niche' that is co-ordinated to something or other, but nobody is quite sure what it should be. A certain number of products for conventional building are related to the brick and might be said to be co-ordinated roughly but not formally.

We concentrated first on the prefabrication systems which really were intended to be modular and tried to appraise the experience which designers, builders, and makers had of them in terms of time, cost and quality. On this aspect we made a fairly detailed examination of the experience of the Architect's Department of the Herts County Council and careful studies of two firms which make parts for prefabricated buildings as well as undertaking site assembly. We have recently added reviews of three timber systems and some others, but for the sake of brevity I will not include details, because the others are sufficient to illustrate this phase.

Studies of prefabrication alone obviously could give us only limited help in applying modular ideas to conventional building, for they omit the brick and block construction which is and will remain for some

time the main substance of the industry. We had therefore to consider how we could make good this deficiency. Fortunately it came to our notice through the meetings of the European Productivity Agency, when the whole project was being discussed, that in Germany modular ideas had been extensively applied to conventional building. We therefore arranged a fairly detailed review of this during the early studies, and it proved most fruitful.

We also put in hand at an early stage some studies relating to costs and to various matters which bear very intimately upon the actual choice of modules, but I will come to these later.

Before I go any further, I must say something about terminology. We all know that 'traditional' building has been changing a lot owing to mechanisation, partial prefabrication and so on and is no longer traditional. We also know that 'prefabrication' can be interpreted to mean all kinds of factory and site manufacture, both wet and dry, as well as whole 'systems' of prefabrication. We need some clarification, and for my own purposes now I am going to use the term 'conventional' to represent the buildings which in British construction are based on relatively heavy combinations of masonry, steel, and concrete, using a fair amount of water and *in situ* construction. Then I shall use 'prefabrication' to mean systems of construction using rather large factory-made components, mainly put together by dry methods; and things like curtain walls, ceiling systems and prefabricated partitions will be generally called 'dry assemblies'.

Architects' Experience. Architects' experience of modular work is more varied and extensive in Britain than might be thought at first glance. Many offices have used planning grids and quite a number of offices have done modular development work of various kinds, sometimes on parts of buildings such as partition or ceiling assemblies and sometimes on whole building systems. All of these play a part in the general concept of modular design, the plan grids because they will normally be spaced on a modular basis and the dry assemblies because interchangeability of parts is entirely dependent on some kind of dimensional co-ordination.

It is not possible to review this experience completely. We have made one attempt to get views about plan grids by advertising in the R.I.B.A. JOURNAL that we want this information volunteered by architects, but it has not brought much response, and we shall have to try some other method. Nor have we been able to cover all the architects' offices that we know are working on modular ideas for dry assemblies, but we hope eventually to visit most of those which are really active. As I said a moment ago, we concentrated initially on the Herts County Architect's office because of their outstanding experience in using prefabricated school construction, and we received so much help from them that I must take this opportunity to say that we are very grateful to Mr. Aslin, Mr. Tatton Brown and their colleagues. But in addition we have questioned a moderate number of other architects, both private and official, who are active in this general field, and all have been very helpful.

The outstanding fact upon which all are agreed is now probably fairly well known. It is that prefabrication on a modular basis can effect a major economy in architects' offices. In the Herts County office the time spent on working drawings for schools was cut by roughly one half. Part of this gain has been absorbed sensibly by giving more time to design and study, and of course the finished schools show the benefit, as they do in other counties working similarly. At the same time, in appraising the economies effected one must remember that the Herts office devote considerable time to development on their own account.

Their practice is to hold a pool of standard details and one might think that the gains are due merely to this, and that they are possible therefore with any standardised system. This is part of the truth but not the whole story. The significant factor is flexibility. You can if you want push drawing office economy to extreme limits simply by the kind of standardisation that goes together only one way, as some of the 'kits of parts' for post-war houses did, and then you do not need to do any drawing office work at all before using the products. But this kind of approach is so inflexible and its use so limited that it has little to do with the main stream of modular co-ordination, a vital objective of which is to facilitate the assembly of building products in as great a variety of ways as practicable. Flexibility is one of the distinctive merits of the prefabrication systems for schools, and its significance in this argument is that flexibility depends largely on dimensional or modular co-ordination and the drawing office economy comes not merely from standardisation alone but from a kind of standardisation that is based on modular working.

It seems reasonable then to infer that modular working applied to building generally can lead to the same kinds of economies, and in fact we see it as one aspect of work later on when we come to active application and development, to ensure that drawing office economy and flexibility is made a specific objective. Even the small architect's office ought to be able eventually to benefit from the standardised detailing possible with modular development.

I am sorry to have taken so long developing this point, but while some people accept it readily others have wondered about its validity.

I have said that we cannot possibly review all architectural experience of modular working, but this does not mean we do not want to know about it. We shall very much appreciate receiving any information that can be sent to us, and we particularly need to know about different sizes of plan grids architects have used and why they chose them. If an architect feels he has more to contribute than he can reasonably put in a letter, we will do our best to come and see him if he will let us know.

Manufacturers' Experience. In 1954 we examined closely the work and results of two of the firms making parts for modular prefabricated schools, and we obtained most interesting information for which I must take this opportunity of thanking the directors and staffs concerned. They were uniformly helpful.

There are many details I cannot review here for I must keep to main points. Undoubtedly the outstanding one is the big increase of productivity and the simplification experienced. In one firm where steel framework is designed and fabricated both on a conventional and a modular basis side by side it was found that each draughtsman on the modular side can see three times as much steel placed per annum as his opposite number in conventional work. In addition to this, advance ordering is simpler and more accurate, less skilled work is needed and the standards of skill needed in the office, in the factory and on sites can be reached more quickly. All these gains were ascribed partly or wholly to the simplification of modular working and all that it implies.

In the other firm much the same sort of thing was found. Estimating was speeded up and made more accurate, and productivity in the design and drawing offices and on site was about doubled. In addition modular working encouraged interchangeability while keeping down jig costs and smoothing out production.

All these are gains but modular working probably does not lead that way in all respects. For instance, it may be generally the case that the standardised use of framing components would make them heavier or more complicated on average than when designed for one condition only, and whether this leads to greater overall costs when offset against other advantages of working on a modular basis will depend on circumstances. Overall costs are generally competitive at present but no marked economy is evident. Possibly this is due to the working of market conditions rather than strict logic, but we must also remember that all this development is in its infancy still.

Many opportunities have been taken to talk to builders and their foremen about their feelings on doing prefabricated work. No clear-cut consensus of view is evident, but it is obvious that such work affects their organisation a great deal because it makes a change in the balance of demand for one trade or against another and in the ratio of total building force to supervisory staff. Some reactions against this were to be expected and were found; but opinions had not formed very fully.

German Experience. The German experience was very interesting to review. So far as housing is concerned, Germans turned their backs on alternative forms of construction after the war and devoted themselves to improving output of con-

ventional work. As a basis for this they introduced a number pattern for dimensional co-ordination into the German Standards (Federal Standard DIN 4172) and required construction and planning to be based on it wherever a subsidy was sought. Although application varies from poor to very good, they claim with reasonable justice that three-quarters of their 400,000 houses in 1953 were modular, and last year they say that virtually the whole of their 520,000 houses were basically modular, which represents a value p.a. of completed buildings of the order of £600–£700 m. The system has been thought out with bricks and blocks as a background though it is probably flexible enough to carry a considerable variety of techniques.

The number pattern or table itself is quite interesting. It is called 'Preferred Building Numbers' and has two sides, one generating from a 12·5 cm. unit and the other from 10 cm. Both sides develop in module intervals, with smaller sub-divisions for certain purposes and emphasis on some larger intervals for other purposes. The 12·5 cm. side is used for bricks, blocks and all carcassing (i.e. construction dimensions), while the latter is used for planning, each cell of a plan generally having its own 10 cm. grid. Each side seems to have emerged from a school of thought that held its particular module to be suitable for both planning and structure, but in practice it is said that the combination has practical arguments in its favour. One is that if the inside dimensions of rooms are laid out on a 10 cm. grid, and the carcase is on a 12·5 cm. basis, plaster finishes, skirtings and so on fill in the discrepancies between the carcase module line and the plan module lines with less resulting trouble than the conflicts which would occur if one attempted to relate basic structure, finishes and planning around one module, and had the thicknesses of plaster, skirting and other trim as an overlap from the carcassing on to the plan grid. The viewpoint must be examined in detail with respect for the experience it represents, though in certain ways it may not attract at first glance. It is of course one aspect of the 'thickness' problem.

The German standard for dimensions is supported and extended by standards for various classes of products, and by Federal standards for storey heights and certain other planning factors.

In operation, as I said, German practice is variable. The best practice, so it seemed to us, was to be found in Schleswig-Holstein, where in addition to the Government organisation there was formed a Society called 'The Working Team for Up-to-Date Building' whose function was to encourage co-operation among the various people concerned with building. Briefly, it then proved possible to concentrate design practice and production around a limited number of the modular standards, chosen to function with an agreed range of room sizes, house depths, roof pitches, stairways and so on. Thus house depths of 6·25, 7·5, 8·75 and 10·0 metres were used, based on a 5-module grid (62·5 cm.), and the floor beam spans are organised in similar increments. Certain conventional relations were fixed between the grid and the carcassing to smooth out assembly difficulties. Production of standard units and assemblies was then organised to correspond to the agreed conventions. The result is a considerable flexibility in design, and an economy which the authorities say brings their houses some 15–20 per cent below the cost of comparable houses in the remainder of the country. It was impossible to appraise the accuracy of this, but given honesty, good standardisation, low production costs in factories, simplicity of design, the advantages of packing for shipping and familiarity on the site, perhaps the figures are not too surprising, and it may be significant that similar figures have been reported for similar work elsewhere.

This is modular practice developed in what seems to be quite a sensible manner for low-cost housing. A particular merit is that flexibility is greatest where it is most needed. For example, a very limited range of modular doors and windows is available, but they can go anywhere on plan and elevation within multiples of the base module.

Table I

Manufactured Window Sizes
(Dimensions rounded to nearest inch)

11	25	38	51	65	75
12	26	39	54	66	76
14	27	42	56	67	78
16	30	43	57	68	81
17	32	45	58	69	93
18	33	46	59	70	94
20	34	48	60	71	
21	35	49	62	72	
24	36	50	63	73	

In sum, both freedom of design and reduction of cost are shown to be possible by the use of products whose dimensions are chosen from a series of related numbers. Modular co-ordination provides this relation and it is used in Schleswig-Holstein to co-ordinate a range of standards. One cannot escape seeing a marked similarity between this development and some of the proposals of the Bailey Committee, and their implementation may deserve more effort than they received.

It is known that both Poland and Russia are using modular co-ordination extensively based on a 10 cm. module and certain preferred dimensions, and there are references to the production of standardised parts which sound not unlike the Schleswig development in principle. But we have not yet obtained much information.

Cost Studies. One effort was made during the year to establish a technique for separating out the economic advantages of modular co-ordination from those of prefabrication by analysis of costs of several schools, but present methods and information were not able to give us what we wanted. It is hoped to make further efforts to obtain such data in the later stages of the work.

The Study of Product Sizes. It will be necessary before very long for us to know what dimensions of important building products are fixed, either rigidly or fairly firmly, by function, manufacturing process, or some other cause, and what dimensions might be changed if there were good reason to do so to fit into an operating modular system. Product sizes which are immobile will naturally influence the final selection of some of the modular dimensions in any framework finally devised.

Although this work was not planned to form part of the general review of experience, the latter had gradually given rise to it, and it is now in full swing. The field has been divided between ourselves and the B.S.I. in a convenient manner to get through it as quickly as may be. I cannot summarise any findings at this stage, but it is proceeding smoothly and once again we must express our thanks in public to the many firms we have visited, for they have all been helpful in every way.

The First Stage in Retrospect. All this early work had several purposes. Chiefly it was intended to give us familiarity with the existing experience, and to reveal as exactly as possible what kinds of advantage might be hoped for in various directions, what order of economy might be expected and what difficulties might already have displayed themselves.

The main observations will I think be evident, but to them must be added Martin's studies at the B.S.I. showing the extent of the present spread and the great lack of order. Some 15–20,000 items are covered by Standards at present and only the vaguest pattern of dimensioning can be discerned.

In looking back over the early work I think I must add yet one more factor, somewhat intangible but very important. Our E.P.A. contract has brought us into touch with the modular authorities of all the principal countries of western Europe, and we have become increasingly aware of the solidity of the movement towards modular co-ordination which is taking place at the same time in so many places, even though the different countries organise the work in different ways and have reached very different stages of advancement. The impression is inescapable that the case for modular co-ordination is widely accepted, if not entirely on proof or demonstration, then on the sheer weight of the 'rationale', which emerges both from the negative feelings that something better than accidental co-ordination must be possible, and the accumulation of positive indications, some minor and some major, that more order is possible, is much to be desired and will become increasingly needed as time goes on.

This seems particularly so in Britain now. Look for a moment at this range of reference dimensions either proposed or already in use for modular design; there are grids of 33, 36, 39, 40, 48, 50, 76 and 99 in., and quite likely I have missed out one or two. As a group they bear no kind of deliberate or systematic relation to one

another nor to any base module, yet some are growing strongly already and threaten to present themselves before long as blocks of entrenched assets and practices which, however good in themselves—and some carry the brightest flowerings of post-war British architecture—may nevertheless easily become an embarrassment to a well-ordered whole.

One can look at it another way. Consider a particular item of construction such as dry ceilings. As I see it, we are likely to want to use the same types in association with many kinds of construction, but in order to do this they must not only be able to work in with load-bearing wall construction, frame construction, curtain walls, and dry partition systems, and be able to accommodate standard light sources, and so on, but then the dry partitions in turn must relate to plan grids for various classes of building, and the curtain walls must relate to windows and panel infillings, and so the chain of repercussions extends. There seems little hope of order here unless we can find a dimensional framework which can meet the varying circumstances of building, yet makes evident at all times a firm pattern of relationships. There is no proof yet that one dimensional framework can do all this, but it seems clear that we must at least seek a solution along these lines.

Modules, Planning Grids and Preferred Dimensions. Initially this problem is best considered in abstract by discussing modules rather than dimensions. As soon as we start dealing with feet and inches it becomes more difficult to keep our minds on the matters of principle which are our first concern.

So far as I know there has been no thorough study or publication of a side-by-side comparison of the operation of the various modular systems now in use. It seems to me such an obvious early step that it came as a surprise to me when I first realised it had never been done. Quite apart from the advantages of avoiding other people's difficulties, such studies help greatly to free one from prejudice and to keep a balanced view. It is not an easy kind of study to make, of course. People who are operating modular systems do not yet seem to have provided critical reviews of the kind which science expects, and without them it is necessary to go and study their operation yourself—always a difficulty when it means another country, another language, a different set of building habits and so on. We have gone some way in this direction, and although I cannot take time for a detailed review of these studies, I would like to draw upon them for some general comments on the two or three main alternatives advocated or already in use.

The simplest concept no doubt is the idea of a single module with all of its multiples accepted as part of a 'system'. In principle it is much the same as Bemis's concept of structure composed of imaginary modular cubes.

I think there is probably general agreement now that to accept all multiples gives too much freedom and too little guidance to serve the major purposes of modular co-ordination, either for architects or manufacturers. The view has consequently grown up that a selection of preferred multiples should be established, but there is no definitive view yet of how this should be done.

Natural selection has been considered, or sometimes accepted without question. Our building industry is extremely varied, and left to its own free will it throws up dimensions in a virtual continuum over the whole range of product sizes—that is, up to about 10 ft. or so. Martin has made many reviews of existing dimensions in British Standards which show this, and even in single classes of products, such as doors or blocks, dimensions occur at astonishingly small intervals over the whole range. To some useful extent, perhaps, there is a pattern running through them; foot intervals are emphasised, and 9 in. dimensions also to some extent. But there is not much hope here, so far as we can see, for the view that natural selection will exclude any useful number of multiples of any particular module. I give in Table I data from Martin's sheet for windows which shows about 92 dimensions in a spread of 100 in., and this is quite typical.

It would be possible of course simply to say that some selection had to be made and to make it arbitrarily. This is not a very attractive line of approach, partly because it is so difficult to make a wise selection when there are so many conflicting claims, as in our industry, and partly because if things are to fit together readily their sizes and shapes clearly must have some rational, flexible relationship.

Earlier I described the German system and of course it is basically of the type which has a full sequence of multiples, though in fact it comprises two sequences side by side generating from separate modules. It has evidently worked for some purposes, but in taking it as evidence one must remember several qualifications. First, it is used mainly for construction using bricks and blocks, for which the first few multiples are the ones chiefly needed; it has not been extensively used for combinations of larger units where the guidance of preferred dimensions is most likely to be wanted. Second: where it appears to have been most successfully used—in Schleswig-Holstein—they did in fact select preferred multiples, but for a strictly limited range of uses, mostly traditional domestic construction. And third, the usefulness of the double sequence has not been fully appraised; we do not know if it was devised of necessity, or from logic, or for compromise, or as a convention.

M. le Corbusier's 'Modulor' is quite a different kind of system, for there is no module in the ordinary sense of the word. He has two sequences of dimensions, like the Germans, each arranged so that each dimension is larger than its predecessor by a constant ratio rather than by a fixed dimension. In other words, they are geometric. Of his two sequences, one has each of its dimensions twice as large as a corresponding dimension in the other sequence.

In setting up his pattern he used a geometric series where it also happens that each term is the sum of its two preceders. Many people know this as a Fibonacci arrangement, and it makes a rather unusual and useful kind of addition possible within the system. His second scale gives added flexibility in this respect when used together with the first. The ratio corresponds to that of the so-called 'golden' section, which is one of the historically important bases of good proportions and the whole system has a strong aesthetic character. One of his key dimensions is taken from the human body, and through this and several other anthropometric dimensions in the sequence he obtains an automatic relation to human scale.

Le Modulor is interesting and ingenious but its suitability as a dimensional framework for the industry seems very doubtful. It is not simple enough to be comprehended readily and used widely on the production side owing, I think, to the lack of a fixed module and the limited and rather obscure possibilities of simple addition within the system; and judged from an aesthetic standpoint also I think it would soon be found wanting because it affords only a limited range of proportions—not more than nine, all told—and these do not include certain important forms.

This review of systems is incomplete but wide enough to show that no ready-made, fully worked-out solution lies to hand for us to take up. The question therefore is whether we can find a better answer. Let us consider this.

The principle of the fixed module as a basic reference point will probably be agreed as offering the most reasonable approach because of its inherent simplicity, and if this be accepted the question then resolves itself into a search for a systematic way of deciding which multiples of a full sequence can be omitted while retaining a number of multiples sufficient for the jobs to be done and having rational relationships amongst themselves. From what I have already said I think we might postulate at least four conditions which a system must meet in order to be successful:—

First—A full sequence of multiples up to about the first half dozen is needed to cover bricks, blocks and other smallish units.

Second—Gaps in the sequence should enter at about that point and increase in size as the multiples themselves increase. The intervals between 30 and 36 are clearly less necessary than those between 0 and 6 for example.

Third—It must be possible to add and combine the smaller numbers in very simple ways to equate to larger ones in the series. This is important if variety of use is to be made possible for products. We speak of this as the property of meshing.

(This principle can be stated in other ways. One could say for instance that the upper range of multiples should be numbers that factorise readily; i.e. that divide readily into other whole-number dimensions. Yet another way is to say that the larger prime

numbers, such as 7 and 11 and their multiples, should generally be omitted because they cannot be made up from equal sized units. There might be some exceptions to this, however.)

Fourth—It must be possible to associate numbers in the sequence to give a wide range of proportions. An analogue might be said to be the well-tempered scale in music, modular in character, capable of wide musical expression but itself aesthetically almost neutral.

If we can meet these conditions we might reasonably think we had found a promising trail. We have been studying the problem, and while we cannot yet claim to have proposals which have been tested to our satisfaction, one particular result is holding our interest for the time being. I will not take time to go through all the arguments of its development, but in principle what we did was to work in combinations of number series to see if merits they possessed individually could be worked together to advantage.

The most promising looking sequence resulted from a combination of an ordinary doubling series (1, 2, 4, 8, etc.) which gives the halvings and quarterings so commonly used in design, and a tripling series (1, 3, 9, 27), which gives the important thirdings, and a Fibonacci arrangement (1, 2, 3, 5, 8) which gives the unusual additive property I described earlier. The whole background was of course more complex than this, but these are perhaps sufficient reasons for the moment. Perhaps this sounds less tidy than it works out to be, for in fact it resolved itself into a simple table (Table II). The Fibonacci arrangement is a spine, as it were, with doublings to right and triplings to left.

Table II

Tripling			Fib.	Doubling			
—	9	3	1	2	4	8	—
—	18	6	2	4	8	16	—
—	27	9	3	6	12	24	—
—	—	15	5	10	20	—	—
—	—	—	8	16	32	—	—
—	—	—	—	—	—	—	—

The table can be extended as desired, but terms larger than 32 are omitted for the moment because with any normal module the dimension then becomes needlessly large for the present discussion.

Perhaps the character of the series will show up better if it is written down as a sequence, thus: 1 2 3 4 5 6 . 8 9 10 . 12 . . 15 16 . 18 . 20 . . . 24 . . 27 . . . . 32 . You will see readily that it meets my first two conditions—the presence of the first half dozen terms and the spreading of the larger terms. In fact it omits about half of the total and cuts the possible combinations of sizes by about two-thirds, within a proportion of 1 : 4. The third condition—the one about ease of adding and combining smaller terms to equate to larger terms—is also met at frequent points on the ascending scale of numbers. You might make your own trials of this, but consider 12 as one example. It is on the table and can be made up from the following elementary combinations, also on the table: $10 + 2$, $9 + 3$, $8 + 4$ and $6 + 6$; or 4×3, 3×4, 6×2, 2×6; or $3 + 4 + 5$, $2 + 4 + 6$, and so on.

The fourth condition referred to aesthetic neutrality. The sequence incorporates 33 forms of proportions, including all that are of any historical importance except $\sqrt{2}$, which seems to us perhaps less important than some of the others both historically and industrially. Actually it is not in fact too difficult to do it by a roundabout method.

The number table thus seems to meet our four conditions, but I must emphasise that this merely merits our saying that it therefore passes the entrance examination to the next stage, which is a programme of study and testing to see whether it meets the main practical requirements successfully. We need to try it with modules of various sizes and see how it provides for anthropometric needs, and for manufacturing in dimensions that producers would find it hard or impossible to change. Planning grid requirements must be set against it. Its relation to structural design, where 'submodular' dimensions are likely to be important, has to be considered, and methods of using the series have to be given thought. For example, the dualism of the doubling and tripling series might raise some problems not yet foreseen. All such questions must have satisfactory answers before the pattern can be made a definite proposal, and it is quite possible that they will lead to changes or even perhaps to a different solution. In fact this is a relatively early stage to put forward the idea, but it seems appropriate to do so because many people are currently interested in the problem and we hope to have the benefit of their views.

For those who wish to examine it in detail I would like to add one or two remarks. First, it should be studied with a variety of modules, both smaller and larger than those usually considered. Also since it is always possible that we might find it useful to have two modules, as others have done, it should be noted that the table seems to offer ways of simplifying a merger. And finally, of course, let it be clearly understood that for any particular purpose one would expect to be selective in respect of the multiples chosen, and not expect all of them to relate to all kinds of construction

It seems to us inevitable that careful study of this kind must precede formal advocacy of a complete modular system, for if it is accepted it will be a major event in the history of building. Such a thing cannot be established or developed hastily and there is no point in moving without the testing and study necessary to confirm its fitness for our purpose, because all the history of technical development teaches us that a system which fails to meet the demands made upon it will not survive.

Future Studies. I have had to dwell so long on the present that I must be very brief about the future.

I said earlier that we had started our studies in industry to see to what extent certain important dimensions are fixed by the functions of the material, the nature of manufacture and so on, because whatever dimensional framework is eventually agreed for general use must be set out with respect for manufacturing dimensions which it is impossible or undesirable to alter. This work is well advanced.

Another influence upon the number pattern is anthropometric data; we do not plan any new work in this field though some needs doing. However, there is a fairly full literature on the desirable dimensions for items related to human use such as doors, cupboards, stairs, what a man can hold and carry, and so on. We hope this will be sufficient for our immediate purposes.

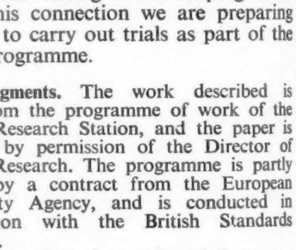
Then there is this question of planning grids, which it is important to clear up and agree upon; but I have said enough about it earlier for you to see our view of its place in the picture. These relate directly to the number pattern.

Eventually of course there comes to everyone in modular work the problems of tolerance and thickness. They are not problems of the pattern but of its use, tolerances being mainly a question of manufacture and thickness a question of conventions for design. Though I will no more than mention them we know their study is very important.

Conventions deserve one additional remark. There are many which we constantly use to carry out both conventional and unconventional building. The introduction of a modular framework for building dimensions would have to be followed by a considerable review of conventions, and it should give firm ground for many new ones to be established which could be the key to much of the economy and simplicity we hope to get from modular co-ordination. Inherent in much of this work is the testing of developing ideas and in this connection we are preparing ourselves to carry out trials as part of the general programme.

Acknowledgments. The work described is mainly from the programme of work of the Building Research Station, and the paper is published by permission of the Director of Building Research. The programme is partly financed by a contract from the European Productivity Agency, and is conducted in collaboration with the British Standards Institution.

The author desired to acknowledge gratefully the work of his colleagues Messrs. D. Foster, J. Kay, R. Wedgwood, T. Carhart-Harris, and of Mr. E. Ehrenkrantz, a Fulbright Fellow in Architecture from the Massachusetts Institute of Technology, to whom the development of the number table is due.



Symposium on High Flats: Part II

Held at the R.I.B.A. on Tuesday 15 February 1955

Dr. J. L. Martin, M.A., Ph.D. [*F*], Architect to the L.C.C., in the Chair

FELIX J. SAMUELY, B.Sc.(Eng.), Lond., M.I.C.E., M.I.Struct.E. **'The Principles of Structural Design.'**

MR. SAMUELY said that a symposium on high flats had been held recently at the Institution of Civil Engineers. The two symposia were complementary and together would form a valuable contribution to the subject.

The ultimate aim was not to put up a structure, but a series of flats as near as possible to the architect's ideal. The cheapest structure was not necessarily the best.

There were two types of structure which suited flats. In the first, the whole bearing structure was on the front and back walls with slabs spanning between. Columns were equivalent to walls. The second system consisted of cross walls which could be either solid or a series of columns and beams. A third system, which he considered antiquated, was a combination of front, back and central spine wall. Prestressed concrete had now made the spine wall unnecessary.

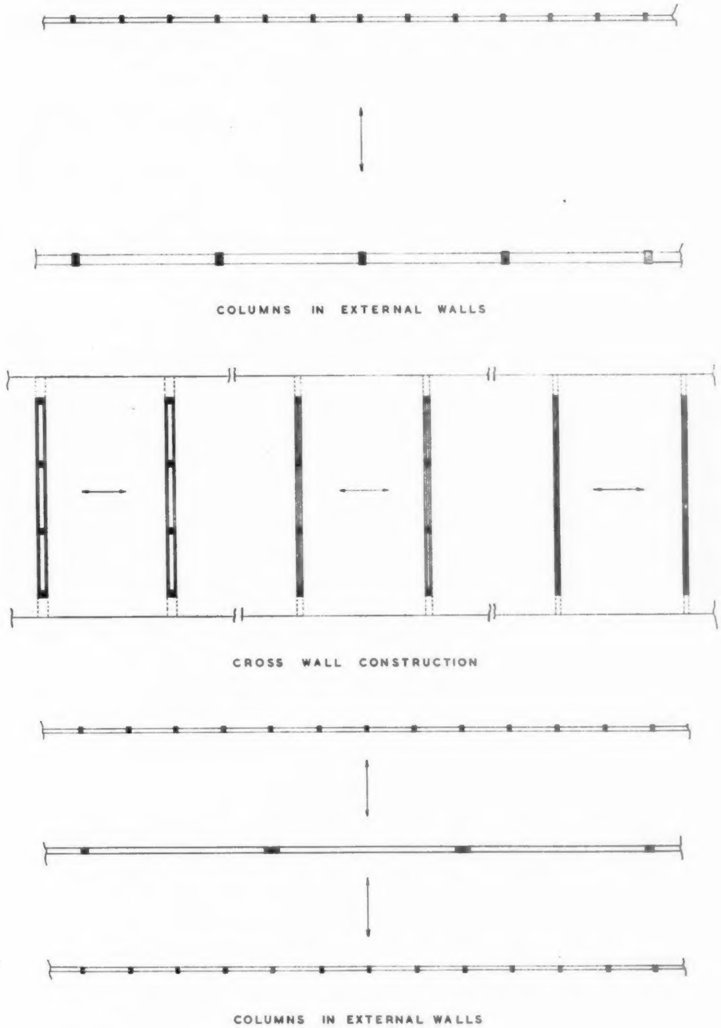
Of the first two systems, the second was the less expensive but only by about 2 per cent in terms of cost per cu.ft. This saving could easily be lost in the flat planning which would make the first system the cheaper. The first system was flexible but required cross walls at 60 to 100 ft. intervals (depending on the width and length of the building) to take wind stresses.

Mr. Samuely then showed slides of a block of flats at Bedford built according to the first system and a block at Bentham Road, Hackney, built according to the second. He continued:

For the Bedford flats there is a clear span of 23 ft. between the external columns, and the ceiling is completely flat. The thickness of the slab is 8 in., and today it could probably be reduced. Generally speaking, the thickness of the structural slab can be assumed as 1/36th of the span between the centre lines of the columns.

I consider that the columns in the external walls should be comparatively close together, say from 5 to 10 ft. The advantage of this is that the edge beam can be very small and disappears in the slab and this makes it possible for the windows to go right up to the ceiling if necessary. In this way the final effect is almost that of a screen of columns, equivalent to a curtain wall, except that it is also the actual bearing construction.

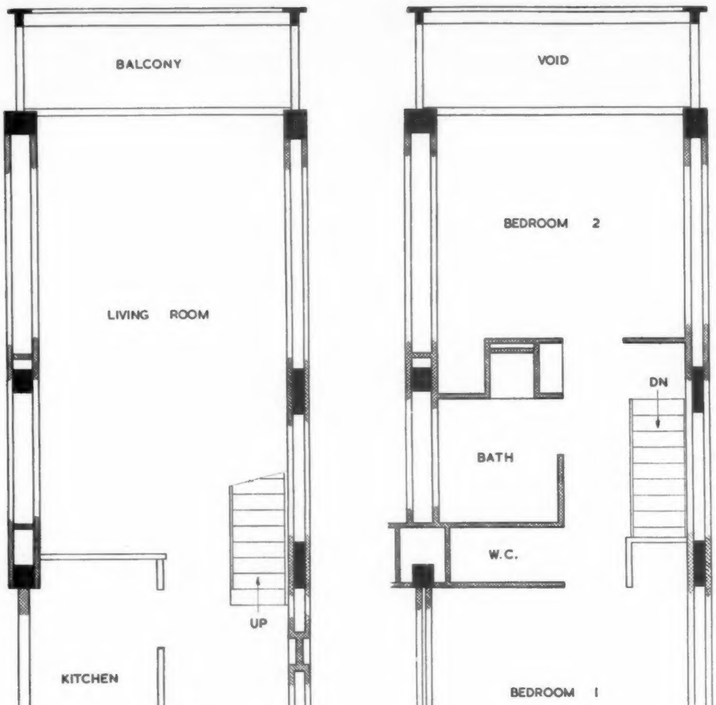
At Bentham Road, Hackney, the main frame is made up of a series of precast two-pinned frames. Whether such frames are carried out in precast or in situ concrete is purely a matter of finance. There is no difference in the final structure so that only financial considerations need be taken into account.



Diagrammatic plans of the three types of structure referred to by Mr. Samuely

In my experience rigid frames with two partition walls are cheaper and better for sound proofing than solid walls. The distance between such cross frames is obviously an architectural consideration, as it depends on the size of rooms required. The smaller this distance the cheaper will be the slab; an economical average is between 10 and 16 ft. The distance between columns in the long direction is, therefore, greater with this arrangement than with the front and back wall construction, and this would of course show in the architectural expression.

Up to now I have referred only to reinforced concrete and not to steelwork. In my opinion steelwork is less suitable for buildings of less than 20 storeys. In most cases the cost of the concrete casing for the steelwork is almost as much as the reinforced concrete, and the only advan-



Typical maisonette floor plan, Bentham Road, Hackney

tage that can be credited to the steelwork is that alterations are simpler. One difficulty that almost invariably arises with steelwork is that stiffening beams are required between the columns, and these beams either project below the slab or else make the slab unnecessarily thick. In reinforced concrete the slab can be used to stiffen the columns.

For the flats at Hackney it was found that prestressed concrete was the cheapest construction for the floor slab even on the short span of 12 ft. I doubt very much whether this would still hold good now because since shuttering came off licence much progress has been made with repetition shuttering in panels which makes in situ concrete cheaper for spans of less than about 15 or 16 ft. For the long spans in the first system prestressed concrete will probably still be cheaper.

On the use of piloti on the ground floors of high flats, Mr. Samuely said they were usually introduced either for purely architectural considerations, or because there were to be no ground floor flats or because shops were to be provided and these required wider column spacing. The extra height in the ground floor gave more depth for beams and it was usually cheaper to let the columns emerge organically from the plan of the upper storeys. Because these columns were usually larger than those above and the beams heavier it was usually better to carry these out in in situ construction. But latticed precast beams could be used to carry the superstructure. Mr. Samuely continued:

As far as foundations are concerned, there is little that I can add to the discussion at the symposium at the Institution of Civil Engineers, i.e. that given reasonably good ground there is no need to be afraid of the overturning moment due to wind or to the heavy loading, as the weight of the construction will be sufficient to deal with this problem, and where necessary a basement can be arranged and the foundations taken deeper until the necessary weight is obtained. I will not go into details here, but will only say that of course it would be best to build high flats only on sites with good ground, but with the average ground conditions to be found in England there is no need to despair anywhere on this account. The flats at Hackney are an example of this. They are founded on almost the worst ground to be encountered around London but the extra costs due to this for the whole building will be about 8 per cent.

As far as cladding is concerned it is difficult to find anything that seriously competes with brickwork, but large precast concrete units can be used, with an internal partition wall, that satisfy the fireproofing regulations. The only limit to the size of the precast units is the transport, and it must be appreciated that for reasons of stiffness the larger the units the thicker they must be. However, units about 2 ft. wide that can span from floor to cill, or from floor to floor, as the case may be, have been used in several cases already, and they have the great advantage that within the limits of the building 'purse' any quality of finish can be obtained.

PETER DUNICAN, A.M.I.Struct.E., of Ove Arup and Partners. 'The Structural Problem of High Flats.'

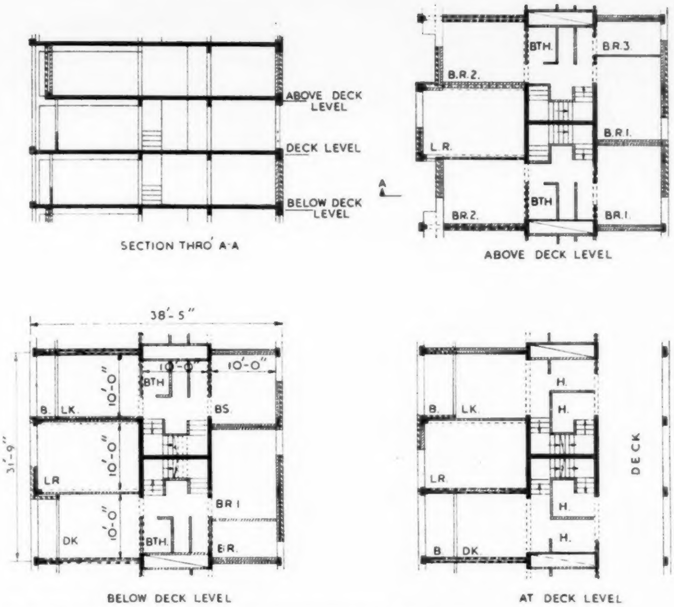
MR. PETER DUNICAN said he thought 15 to 20 storeys would be the optimum for the next decade or two and he was therefore taking 20 storeys as a basis. If 20-storey homes were to be built cheaply and quickly the structural design must be completely integrated with the architectural conception and the building process; the solution of the structural problem could not be considered in isolation.

The main structural problem, Mr. Dunican said, was to ensure the overall stability of the building; wind forces, foundation movements and their effect must be taken into account in the design. This might not mean much in the structure of an over-square point block, but it could be of considerable consequence in the design of a narrow slab block where, for instance, the ultimate differential settlement of a slab raft foundation of a 10-storey block 230 ft. long on London clay had been calculated to be about 4½ in.

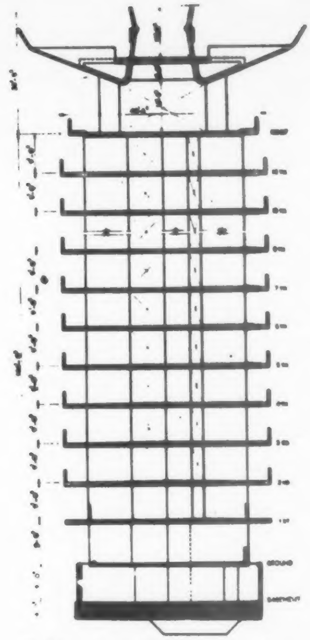
The ease of solution of the problem depended largely on the architectural conception and degree of collaboration with the structural engineer. For instance, if suitably arranged, the usual wall complex supporting and surrounding the lifts and staircases forming the vertical access to a slab block could help considerably in providing the required degree of overall stability without any additional cost.

Mr. Dunican continued:

The basic structural possibilities are limited. For the vertical elements we can have columns or walls, and horizontally we can have slabs with or without beam stiffeners. We can use either structural steelwork or concrete—by structural concrete I mean reinforced concrete, prestressed concrete or a plain concrete of structural quality. I do not think brickwork is a possibility for a number of reasons,



Typical structural arrangement of maisonettes, Sheffield



Golden Lane Housing, London. Typical section

perhaps the most important of which is that the production process at the moment is limited by the bricklayer's inability to lay more than one brick at a time.

The first task of the horizontal elements is to provide the floor and the roof to the dwelling by (*a*) supporting the contents and its occupants, and (*b*) providing a fire and sound barrier between dwellings.

The vertical elements' main job is to support the floors but at the same time they, or some of them, are also required to resist the horizontal wind force. If these elements are columns they resist the wind force by working in combination with beams, which can also be used to support the floors. In certain circumstances the stiffening beams can be replaced by the panel infilling forming the party wall between dwellings, but this solution has a number of limitations.

However, the use of columns generally leads to a framework where the lower storey columns become quite big owing to the magnitude of the direct load and the large wind-bending moments. Nevertheless planning within dwellings with this type of structure is not very much restricted, although sometimes the columns and beams stick out rather awkwardly in undesirable places.

Mr. Dunican said that the main alternative to beams and columns was the cross-wall structure where the walls could usually carry the direct load and wind force without any increase in their size. But the use of cross-walls could restrict the planning as they must be more or less straight, regularly placed along the building and maintaining the same position in the height of the building. The beam and column framework could be built in either structural steelwork or concrete. Structural steelwork appeared to speed up and simplify the construction but it had been found to be an uneconomic solution. Structural concrete could either be completely in situ, completely precast, or a combination of precast and in situ elements. For the cross-wall structure, however, concrete was the only worthwhile possibility. Although theoretically a completely precast system was possible, Mr. Dunican did not think it could compete economically with the combined in situ precast system.

Mr. Dunican went on to say:

According to the Building Research Station, the party structure between dwellings, that is the walls and floors, should weigh about 80–90 p.s.f., which is equivalent to approximately 7 in. of concrete. This should ensure a reasonable degree of sound insulation. The floor slabs should also incorporate an insulating layer, such as glass quilt, but the thickness of the solid structural floor should not be less than 5 in. The party floor requirements can be met equally well in a beam and column or a cross-wall structure. To meet the party wall requirements in a beam and column framework, however, requires either the use of 9 in. brickwork or an equivalent cavity wall construction using blocks. This panel infilling for the party walls will stiffen the beam and column framework, but at the same time the construction of these panels can inhibit the building process.

Mr. Dunican considered that the higher Continental examples were misleading, as they were not houses but hostels for single persons with a cross-wall spacing of about 9 ft. In any case the bottom six storeys of the 19-storey Stuttgart block were in structural concrete.

In no-fines concrete, Mr. Dunican said, the main advantage claimed was the speed of construction; the cladding of the building being made at the same time as the structure, although it was still necessary to apply a further finish both internally and externally. Another advantage claimed was the saving in shuttering, as only an open timber frame covered with wire mesh was necessary for the walls. Speed of construction could also be obtained by using sliding or climbing shutters, which at the same time produced a finished external face of very high quality. Mr. Dunican went on to say:

I think the use of maisonettes in high flats is only just being realised. This type of plan usually results in cellular building which exploits the advantages of cross-wall construction. Another structural advantage is that owing to the lower functional requirements within dwellings, the intermediate maisonette floor can be in timber, thereby reducing the self-weight of the structure, which helps the foundations.

The 11-storey slab blocks for the London County Council at Picton Street are a development of this type. Owing mainly to the use of a narrow frontage unit, it is possible to omit the reinforcement from the alternate cross-walls, which are only 7 in. thick. The walls are cast in situ at about 12 ft. centres, and the floors are precast slabs about 3 ft. wide. End-on overall stability is mainly provided by the staircase lift shaft wall complex. A 14-storey slab block of flats now under construction in Denmark has a similar structural system to Picton Street. The walls are alternately spaced at 3 m. and 4·2 m. centres and are mostly unreinforced. The floors are precast and the construction is carried out by the two mobile tower cranes.

Mr. Dunican said he was of the opinion that for blocks with mixed accommodation the use of walls was limited to dealing with

the wind forces. The main vertical structure must be columns as these offered the minimum restriction to the interlocking flexibility which was imperative for this type of planning. In his view, it was not possible to be dogmatic about structure; engineers each had their own particular preference, but it mattered little whether you had columns or walls or both. A detailed comparative analysis of two or three possible structural schemes would be of use in making a final choice, but usually the differences were marginal; the best structure, he thought, was the one which allowed the maximum mechanisation of the building process.

Talking of foundations Mr. Dunican said that the main types we all had used would continue to be used for high flats. In most cases the safe bearing capacity of the sub-strata could be predicted with reasonable accuracy, although it was not always so easy to determine the most economical type of foundation to use. There were four main types; spread footings, rafts, piles and piers, but as it was probable that our high flats would be founded on clay it was likely that only a raft or a piled foundation would be needed. In either case the effect of differential settlement on the structure would have to be considered, although this was generally less in a piled foundation than with a raft. If it was necessary to excavate more than 12 ft. for the raft it was also cheaper to use piles, which should preferably be of the driven in situ concrete variety mobilising the full shear strength of the clay. Mr. Dunican continued:

Alternatively it may be necessary to use a cellular raft to reduce the additional load which is being placed on the bearing stratum. Professor Skempton's solution for the 38-storey high Paddington blocks employs a stiff 60 ft. deep box sub-structure with stepped ends to increase the bearing pressure at the ends of the raft and reduce the differential settlement to manageable proportions. Such deep foundations are probably out of the question for flats, and the superstructure will still be required to deal with some differential settlement, although the cellular raft principle will reduce the magnitude of the problem by keeping down the applied loading of the bearing stratum to the minimum.

Mr. Dunican thought that high flats meant light cladding. As buildings became higher, massive non-structural cladding employing bricks, blocks or slabs must become increasingly uneconomical; the overcoat and raincoat needed could be provided more efficiently by lighter forms. It might be cheaper and better to provide these two coats separately, but as far as possible the cladding should completely enclose the structure, as by so doing the difficulty of the joints between panels would be greatly simplified and the problem of dimensional tolerance of the structure and cladding would be easier to handle. An economic argument existed in favour of light cladding, bearing in mind the savings in structure which occurred because of the considerable reduction in dead weight. Mr. Dunican concluded by saying:

I believe the economic solution of this problem depends fundamentally on the architectural conception. The cost of the structure of a block at the most is about one-third of the total cost, and perhaps this indicates the size of the engineer's contribution. In the ultimate, however, building is mainly a problem of material handling, and this is the special province of the contractor. Organisation is the key, although I think that contractors have been helped considerably in this by the development of the tower crane, which has had far-reaching effect not only on speed but on the cost of building.

The tower crane imposes a discipline on the job, and although some structures are better suited to accept this discipline than others, in the end the tower crane is only another machine to help to build high flats. To start with you need the team of architect, contractor and engineer, whose task must be to produce and build the best solution to the particular problems.

C. D. MITCHELL of Wates Ltd. **'The Contractor's Viewpoint.'**

MR. C. D. MITCHELL said that the problem of designing and building high flats was a challenge which had to be met. We had a lot to learn from elsewhere, particularly America, where he had been impressed by the excellence of the buildings but above all by the teamwork of all concerned, principally the architect, engineer and contractor, long before the work was due to start. He believed that in this country also the contractor had a lot to contribute in the pre-planning of a job, and that his wide and unique experience in matters of plant, costs and technique was too often neglected. Mr. Mitchell went on:

A firm step towards a more organised production was taken when we had the opportunity of building an 11-storey block of flats for the L.C.C. at Trinity Road, Wandsworth. The contract is one for five 11-storey blocks of flats each approximately 64 ft. square with a reinforced concrete frame, clothed with an outer skin of 4½-in. brickwork, a cavity and a 3-in. clinker-block lining. Each block with its penthouse is about 120 ft. high and is planned with two lifts and two staircases. The whole job is centrally heated from an independent boiler house. The total value is about £450,000.

Mr. Mitchell referred to the very co-operative reception his firm had received; he had found a complete set of drawings and was told that any suggestions made that would increase speed or ease of construction would receive careful and sympathetic consideration; and he remarked on the invaluable assistance he had received from everyone concerned.

Mr. Mitchell said that work to the foundations of the first block began in February 1954, the first block was virtually completed and he expected to complete the whole contract by July—some four months earlier than the contract date. Mr. Mitchell continued:

When considering the erection of a new building, I always try to search for the structural ideas which the designer had in mind and to develop from then on. To a contractor, the bones of the building are the most important. In this case, the bones are readily discernible in the form of an in situ R.C. frame with a precast staircase. But we never like mixing reinforced concrete work with general building work. We don't like cladding the concrete frame with a forest of steel scaffolding which is then for ever in the way of the bricklayer and other trades. We don't like the work entailed in shuttering horizontal beams, carpenters hopping up and down on trestles fixing timber 8 ft. or so in the air—a laborious, strenuous and costly business. We don't like pouring concrete walls in 3-ft. lifts as is so often specified—in other words, in the interests of speed and efficiency we prefer to eliminate a lot of the older methods and to adopt new and more simple techniques.

Mr. Mitchell said that his firm were used to knitting together large precast elements with in situ joints, and that in considering the problem of building the Wandsworth flats he had concentrated on the possibility of using this experience to advantage. A crane was essential and in this case he had felt that the new French tower crane was the right tool for the job, and one was bought. It was a fine piece of machinery and had completely proved itself. Planning of the job had centred round the crane and its capacity. The precasting of all the balcony slabs and horizontal beams was considered, to eliminate practically all the intricate carpenters' work, and it was hoped that the walls could be poured their full height of 8 ft. 2½ in.

Mr. Mitchell continued:

This is where the co-operation to which I have previously referred played its full and very important part. I am glad to be able to say that the architects, the engineer and the District Surveyor, after due consideration, gave their full approval to my proposals and made one qualification—our proposals must not in any circumstances involve the client in any additional cost.

These important departures from the original design having been decided on, a scale model of a typical floor was made, showing clearly the parts to be precast and those to be cast in situ. The balconies and stairs were made off the site in a concrete works, but the beams were cast on the site. Landings as well as flights were entirely precast and came to the site complete with a high-grade granolithic finish, and as each floor of the concrete structure was built the landings and stairs were placed in position by the crane on precast concrete nibs cast into the side walls, and were then immediately protected by pre-made light timber casings. Access to each floor was thus immediately given. Balcony fronts were designed in one piece and could be placed in position on the precast balconies, the fixing bolts being grouted in position in pre-formed holes—a very quick and efficient solution.

Trinity Road flats, London. The tower crane and first block

Trinity Road. Frame completed two months after view on left

Trinity Road. Brickwork being built from suspended scaffold

Trinity Road. Glazing being done as scaffold descends

Several types of shutter were made experimentally at our plant depot, and as a result it was eventually decided to use 18-mm. plywood in sheets of 8 ft. by 4 ft. on 3 in. by 2 in. framing: where possible the shutter was of a size completely to shutter the wall for which it was to be used. In addition, a working platform for the concretors was fixed to each shutter so that when it was in position, both the shutter and working access were provided.

The first slab shuttering was formed with telescopic shutters spanning in the main from wall to wall and covered with sheets of 8 ft. by 4 ft. plywood, each clearly numbered. These sheets were marked out to show position of ventilation ducts, holes through the floor and the like.

When examining the drawings for the reinforcing of the steel it was noticed that a large number of sausage links were required to separate the two vertical layers of reinforcement. Our suggestion to eliminate these and to substitute steel ladders made from $\frac{3}{8}$ in. diameter uprights and $\frac{1}{4}$ in. diameter welded on at the correct centres was accepted.

It was planned to construct each floor of the concrete frame in 7 working days—a time which was quickly achieved and has been consistently improved upon, the best time so far being 4½ days. All this has been achieved with a gang of 25 men—5 concretors, 10 carpenters, 5 carpenters' labourers and 5 steel fixers.

An investigation, Mr. Mitchell said, was made into the possibility of loading each floor with the bricks and clinker blocks required for the external wall and internal partitions. The position and size of each stack was agreed with the engineers and sufficient pallet boards were made so that the brick and slabs could be unloaded from the lorry on to the pallet board and so save double loading. Mr. Mitchell went on:

Having completed the penthouse, we then asphalted the roof, following this immediately by the erection of steel outriggers mounted on the roof, from which our scaffold for the erection of the brick cladding was hung. As this was raised lift by lift, bricks from each floor were handed on to the scaffold. Mortar for the bricklayers and materials for the plasterers were supplied by means of a high-speed hoist. The outer skin was constructed at a rate of 2½ floors per week, i.e. 4 to 5 weeks per block. This method of scaffolding enables the bricklayer to proceed without interruption, always keeping his work at a reasonable height, and eliminates the staining of the work which a standard scaffold so often gives. The brick-laying gang having raised the scaffold to the roof, the glazing and painting of the windows was carried out from the scaffold on its way down to the ground. While the external skin was being erected all trades could get to work internally under cover of the asphalted roof.

Mr. Mitchell explained that as it was not proposed to use an external scaffold for the reinforced concrete frame it was necessary to give security and confidence to the workmen, and the idea was adopted of fitting each external beam with a metal guard rail and toe board. The guard rail was fixed to the beam before it was erected, so that as the crane dropped it in position the protection was already there. The external suspended scaffold was enclosed with a curtain, to reduce the sense of height.

Lavatories were provided on a number of floors throughout the building, and tea was taken to the men working at the higher levels. Mr. Mitchell concluded by saying:

I would emphasise that the completeness of the drawings at the very beginning gave us a flying start, and the job has thus never looked back. The often inevitable change of mind just did not happen. My experience on these buildings confirms my view that reinforced concrete buildings of this kind, floors, walls, columns and stairs, all parts of a whole, have many advantages over steel-framed buildings, and I think I may well claim that the speed of construction of these buildings disposes of the often repeated claim that steel-framed buildings are quicker. If town planning and other considerations increase the demand for these high buildings I am quite certain that the disparity of cost, already rapidly decreasing, will disappear in the not too distant future. In fact the combination of site costs, foundations, building costs and the increased speed of building, together with the increasing efficiency which is already within our grasp, should all encourage our planners to proceed with confidence.

DR. J. C. WESTON. 'Economics of Multi-Storey Flats Design.'

DR. WESTON said that in most Continental countries a flat in an 8- or 10-storey block cost only 5 or 10 per cent more than an equivalent 2-storey house. The wide differences in cost in this country were exceptional. The Building Research Station were making a survey of flat costs, based on tender prices excluding land and external work. For this, housing authorities had been asked to provide information on prices, not only of the complete block, but also of components such as structure, heating, lifts, etc. The blocks investigated ranged from 3 to 12 storeys and contained one-to-four-room flats. On the average there were three habitable rooms per flat, corresponding roughly to a 2-bedroom house. Dr. Weston went on:

There was found to be considerable variation in the price per square foot of floor area, even for flats in buildings of the same height. Some of this arises from the varying dates of the tenders, which cover a period 1952–54, and also from the differing sizes of flats. It is well known that reduction in floor area without other design changes leads generally to an increase in the price per square foot. Some allowance has, therefore, been made for this effect and the prices have been brought to the level of June 1954 by means of published information on the labour and materials prices.

The figures given by the authorities are the prices estimated by the contractors and not the actual cost of the work. While the latter would be a more satisfactory index for comparison, such data are not generally available and the tender prices have at least the merit that they represent more or or less what the client will pay.

While this study is still in progress—and for it further information would be welcome—the present data does give a clear picture of the general level of costs and, what is even more significant, the wide range of costs for what are nominally similar buildings.

Fig. 1 shows the price per square foot in relation to the height of each block of flats. In this case the net area is used, that is, excluding all access space, lifts, stairs, hall and landing but including space within each flat and such other useful areas as storage, laundries, etc.

Two points are immediately apparent: first, that while up to five storeys there is a fairly consistent increase in price, in the higher flats this is not so marked. However, and this is the second major point, in the 6- to 12-storey region there is a wide range between the cheapest flats costing around

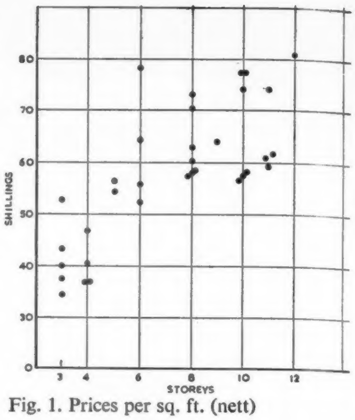


Fig. 1. Prices per sq. ft. (nett)

55*s*. to 60*s*. per square foot and the dearest costing over 80*s*. At the present time a 2-bedroom 2-storey house costs, on an average throughout the country, around 32*s*. per square foot. Even the cheapest of the 6- to 12-storey flats are, therefore, about 80 per cent dearer (per square foot net) than 2-storey housing, and the worst cases are around 2½ times as dear. This very wide range may in part be due to the fact that flats are being built to slightly different standards in different parts of the country, but the range is so large as to suggest that there is still considerable scope for improvement both in design and the efficiency with which the work is executed on the site.

The price per square foot is in some ways an unsatisfactory index since it takes no account of the fact that most flats are rather smaller than houses providing equivalent accommodation. The average size of the flats so far included in the survey is 712 sq. ft. while the corresponding 2-bedroom house would probably have about 10 per cent more floor area. From the data, the cost per habitable room (that is, living-room or bedroom only) has been calculated and Fig. 2 shows how this varies with height. Owing to the more or less constant space occupied by kitchen, bathroom, w.c., etc., in flats with different numbers of bedrooms, the cost per habitable room tends, other things being equal, to be larger for flats with fewer habitable rooms. This increases the range of cost per room somewhat though the effect is not very great in Fig. 2, since the majority of the blocks in the survey averaged near to three rooms per flat, corresponding roughly in accommodation to a 2-bedroom house. It would seem therefore that the price of the cheapest 2-bedroom flat in blocks of 6 to 12 storeys would be about £1,800 (that is £600 per room), there are but few below £2,000, and the average is of the order of £2,500. These prices may be compared with those for 2-bedroom 2-storey houses which, on average, are at present under £1,300, while the cheapest may be not more than £1,000.

Of course, it remains an open question to what extent the accommodation provided is really equivalent and it certainly cannot be assumed that because the prices of the

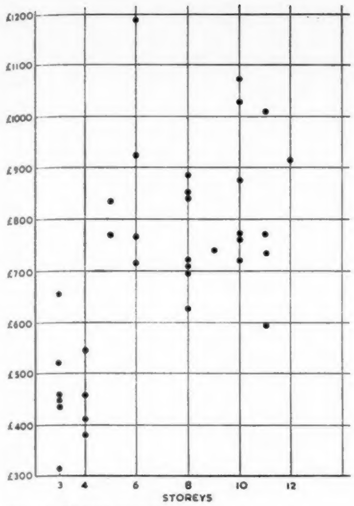


Fig. 2. Prices per room

cheapest flats are substantially higher than those of 2-storey buildings the costs of flat building are necessarily excessive. A certain area in any block must be devoted to provision for access and while the price of this is included, the space occupied is excluded from the net floor area. It is useful therefore to consider the price per square foot of total floor area (price per square foot gross). Naturally, because of the larger floor areas involved, these prices are somewhat lower than those of Fig. 1, though the general picture remains the same (Fig. 3) and in the worst cases the price is still twice that of 2-storey building. On the other hand, one of the 10-storey blocks is not so markedly different in price from that of 2-storey work in the same region. This particular block, whose price was 43*s*. per square foot (gross), was built in the London area where 2-storey work may well be priced considerably above the general average of around 32*s*. and, in fact, be rather nearer to 40*s*. per square foot. This suggests that the wide difference that is common between multi-storey and 2-storey work is by no means inevitable in this country.

The difference between the price per square foot on the net and gross basis (Figs. 1 and 3) is of course a reflection of the proportion of space occupied in providing for access. In flats without lifts this was found to range from 5 to 12 per cent of the gross area and in the taller blocks, with lifts, from 10 to 25 per cent. It would be difficult to give a recommended figure for the proportion of space which should be given over to access but with space priced at around £3 per square foot the use of 25 per cent of the total area for access certainly calls for examination.

This is of course a design question, and another matter of the same kind which is worth attention is the range which is found to exist, according to the shapes and depths of the blocks, in the area of external walling required to enclose a given area within the block. In the worst case the external walling

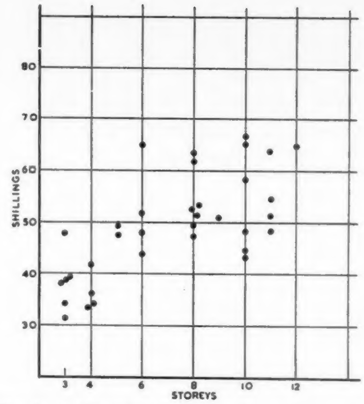


Fig. 3. Prices per sq. ft. (gross)

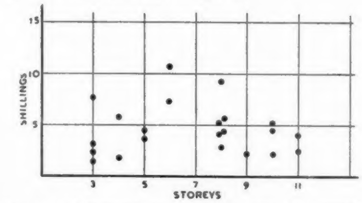


Fig. 4. Substructure prices per sq. ft. (gross)

was just about equal to the floor area enclosed, while the best is about 30 per cent less. This may not seem a particularly large difference, but not only is external walling or cladding expensive but excessive external walling causes a corresponding increase in the heat loss of the building.

Figs. 4, 5 and 6 provide a further breakdown of the price figures into works below ground, superstructure and finishings and services (excluding lifts). The wide variation in the price of flats of more or less the same height is again notable. This is perhaps understandable for substructures but not for finishings and superstructures. In the latter for example the cheapest 10-storey block cost 14*s*. 9*d*. per square foot gross, while the dearest 11-storey block was well over twice as much. The rate of increase of cost with height is, as might be expected, much more marked for the superstructure than for finishings and services. This is true, too, of the individual components which make up these items, but a detailed discussion of this would be outside the scope of the present paper.

Although the different forms of structure are distinguished in Fig. 5, it would not be wise at this stage, in view of the wide range which exists even for the same form of construction, to draw definitive conclusions regarding the cheapest form of structure. In fact, the main point to be emphasised is the wide range which exists even for substantially similar structures.

It is often alleged that one of the main causes of the high cost of multi-storey flats, particularly over five storeys, is the cost of lifts. In Fig. 7 are plotted the lift prices as a percentage of the total price in terms of the number of flats served. It is clear that the price of lifts is not in many cases a serious financial problem.

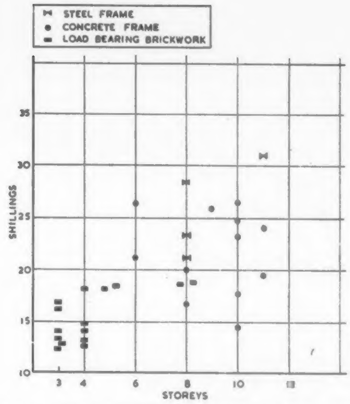


Fig. 5. Substructure (excluding finishes and fittings). Prices per sq. ft. (gross)

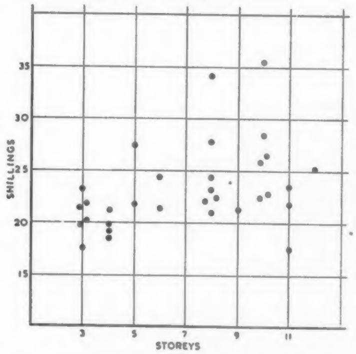


Fig. 6. Finishings and fittings (excluding lift). Prices per sq. ft. (gross)

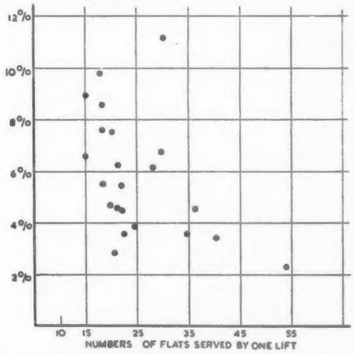


Fig. 7. Prices of lifts (excluding wells) as a percentage of total

Dr. Weston concluded by saying that the survey touched on the broader aspects of the problem only and that further work was needed.

J. H. FORSHAW, C.B., M.C., M.T.P.I. [*F*], Chief Architect to the Ministry of Housing and Local Government and to the Ministry of Health. **'A critical summary of the papers read.'**

MR. FORSHAW said it was important to remember that today when we used the words 'high flats' we were thinking of high

dwellings not in isolation but as elements within areas of mixed development. There were two aspects for consideration: (1) high dwellings for a small percentage of people living in areas of low and medium densities and (2) high dwellings for a much larger percentage living in neighbourhoods of the highest density.

From Mr. Whitfield Lewis's paper Mr. Forshaw picked out first the question of cost—the statement that mixed development had not proved more expensive than the older uniformly high blocks: and secondly a question of design—the increasing use of maisonettes, especially in 4-storey blocks. The one feature calling for improvement in the schemes described by Mr. Whitfield Lewis was the low percentage of houses—4 per cent, 8 per cent, 10 per cent at the most. London should do better.

Mr. Lewis had hit out at the subsidy structure as favouring flats and had asked why in a mixed scheme house and flat should not have the same rate. The difficulty would largely disappear if the gap between flat costs and house costs were closed by lowering the former. To seek to reduce the gap was one of the principal aims today. As a first step Mr. Forshaw thought ceiling heights should be brought down to the bye-law minimum.

Mr. Lewis had also stressed the question of heating. We were told that 400 dwellings in grouped blocks were the economic minimum for a boiler house, but Miss Willis had said that central heating was preferred to an open fire despite additional charges.

In Mr. Cleeve Barr's paper points calling for special note were: the economy of internal bathrooms combined with stack plumbing; the urgent need of a simplified Garchey system of refuse disposal; and the value of the shunt flue, if feasible.

Dr. Bradbury had suggested a review of the top limit of housing density and thought there might be good reasons for using pockets of very high density within neighbourhoods. He had remarked on various features of high flats in New York—the absence of balcony access blocks and the universal use instead of slab or cruciform blocks. He had said that modern ventilation made internal corridors feasible, also the internal bathroom; thus economising in cost and floor space. He had pointed to a need for better landscaping, more playspaces for children, car parking, and for the extent of the provision of such things to be decided at the layout stage.

Major Jensen had related the subject of high flats to that of high densities and thought, after research, that an economic solution could not be found at the present density. Mr. Forshaw thought it might be necessary to re-examine the present accepted levels of density, especially before slum clearance got into full swing.

Mr. Sheppard Fidler had drawn attention to the difference in the capital costs of house and flat building. Flats appeared to cost 50 per cent more and no one had so far been able to say why. He had spoken of the economy of the repetition of blocks and of units within blocks and in this connection Mr. Forshaw said he would like to suggest consideration of the recommendations of the Bailey Committee.

Mr. Frederick Gibberd had admitted that at densities of 60 or 70 rooms per acre in medium-sized towns, suburban areas and the New Towns, tower blocks were not economic, but thought they should continue to be built because of the pleasure they gave to occupants and neighbours. He had mentioned Harlow's policy of employing separate architectural firms for various works in order to obtain variety, which Mr. Forshaw thought a good policy.

Mr. Lack's paper had indicated vividly how the architect should plan to ensure public safety without extravagance. Over-elaborate provision of, for instance, staircases could tend to defeat simple well-organised fire methods. Money could often be saved by early consultation with the fire authorities, but it was essential for the architect himself to understand a good deal about the subject. Mr. Forshaw went on:

It is convenient at this point immediately following Mr. Lack's study to refer briefly to the planning of towers having regard to lift service and staircases. The 'tower' forms a suitable plan-shape for smaller units of accommodation, but increasing use will be possible only if structure and installation costs can be reduced. The cost of installing and running a lift service is very much higher per flat than in other types of blocks. It is not easy to plan satisfactorily with only one staircase and yet take advantage of the revised requirements for means of escape.

The tower is expensive to service because normally it has two lifts and two staircases. What can be done to reduce costs? One proposal which we are examining takes the form of 'twin' towers. The plan follows that of the towers at Bellahoj, Copenhagen, with this difference, each tower—that is half the block—has four flats per floor instead of two in the Danish scheme.

A twin tower, eleven storeys high, would contain 88 flats, and two lifts only are intended, one in the centre of each tower separate from the staircases. An enclosed way would allow tenants to cross the flat roof (as at Pimlico) during times of servicing or breakdown. The reliability of modern lifts in practice means that stoppages are rare, and servicing can be notified. Three staircases only are required—one between the twin towers and one at each end of the complete block, and these link up with the back doors opening on to short balconies. The lift in the centre of each tower gives access to the front doors in a common hall.

Compared with two blocks of typical types now building, the twin-tower block described would save about £8,000 on lifts and wells and £2,000 on staircases—a total of £10,000 or no less than £113 a flat. A further economy due to the space saving nature of the plan could probably be expected. Furthermore, the cost of running and maintaining the lift service would be reduced by about £2 3*s*. 0*d*. per annum per flat for the whole 88 dwellings served. The combined effect of reduced capital costs, and running costs for lifts would reduce the rent by 2*s*. 8*d*. per week on every flat. We cannot neglect savings of this order.

Mr. Forshaw then went on to the question of cost, which obviously dominated all others. The present cost of building flats was fantastic. They could not be let at rents which tenants could pay without burdensome subsidies. Major Jensen had been bold enough to express the view that the cost of building flats could be brought to an average of £1,500 net. Mr. Forshaw said:

Consider broadly what this task would involve and what are the chances of fulfilment. Various average cost figures are stated, but for examination an ascertained average gross tender figure is taken of £2,200 for flats of a typical area, 650 ft super in a 10-storey block. This figure of £2,200 can be broken down into four parts: site works, including drains, roads, paths, boundary walls, garden work and planting, playing and drying areas, £150. Foundations, £150. Carcase, including reinforced concrete structure, brickwork and internal partitions, £925. Internal finishes, fittings, equipment including doors, windows, paving, plastering, painting, plumbing, electric, gas and lift installations, £975. Total, £2,200.

From this breakdown it would appear that an average cost of £1,500 per flat is well nigh impossible, without drastic alterations in standards.

When, however, each part of the breakdown is examined separately it appears reasonable to draw certain conclusions in respect of flats of more than ten storeys:

1. The average cost of foundations and site works should tend to decrease rather than increase.

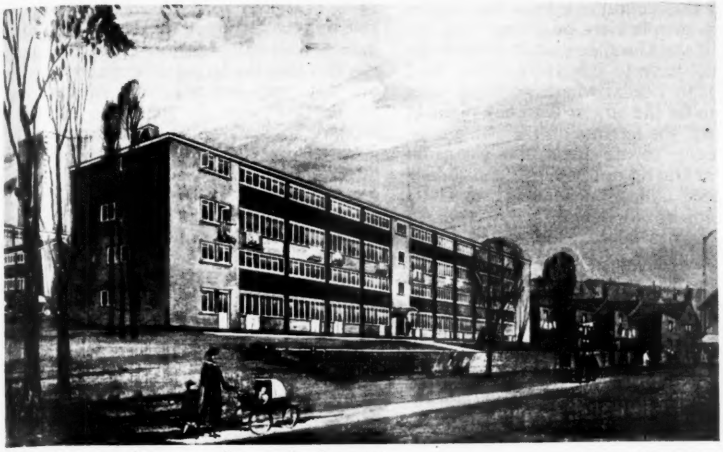
2. The cost of internal finishing and equipment should at least remain constant.

3. There may be an increase in the cost of the structural frame, but this should be offset by: (*a*) saving on the average cost of a roof because it will cover more flats; (*b*) the saving derived from additional output in consequence of more repetitive nature of work, and increased efficiency of skilled working gangs. This latter factor has been exemplified by the experiences quoted by Mr. Mitchell.

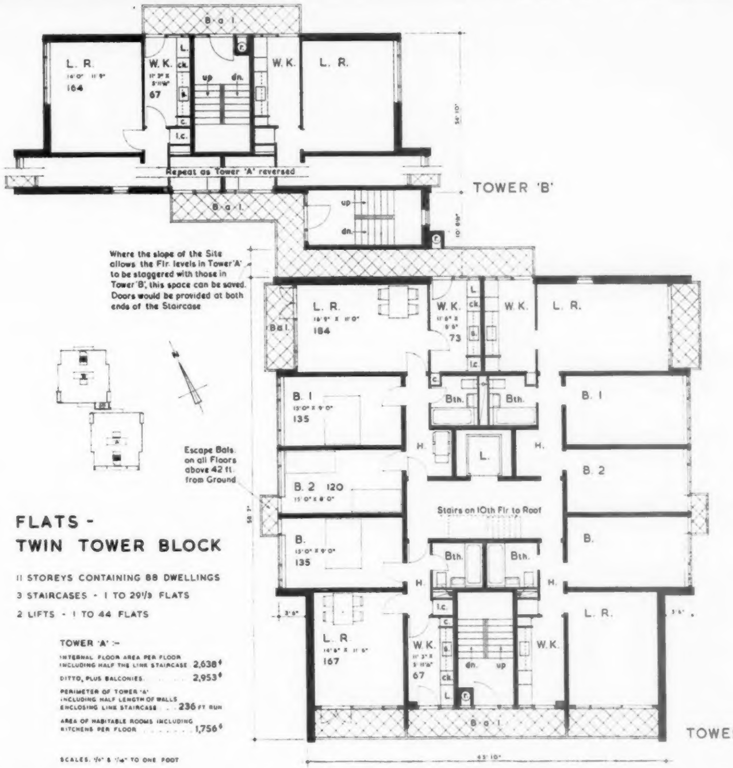
4. Consequently the price of flats in blocks of more than ten storeys should not increase, but tend to decrease slightly.

Dr. Weston's paper records a wide and expensive range of prices. The effect is to impel a search for economies within the present range of construction rather than risk a further climb. It brings us back to realities—hard facts and figures.

The time available to Dr. Weston has permitted him to touch the fringe only. He has presented a range of the prices per ft. super for flats of all types without any classification. Separate prices for staircase or balcony access are not given, nor is the detail of accommodation or other heads stated which affect price comparisons. A general picture of comparative costs nevertheless can be gained. The range of tender prices ascertained is a guide for consideration of the economic overall costs of development. It can serve, too, as



Four-storey maisonettes for redevelopment areas retaining domestic scale. Drawn by John M. Poole [A], Ministry of Housing and Local Government



Perspective (above) and plan of high flats in twin towers. Drawn by A. A. Bellamy [A], Ministry of Housing and Local Government

a key to the economic mixture of high and low blocks in order to bring down the average cost per dwelling.

Dr. Weston's preliminary conclusion, that the price of lifts is not in many cases a serious financial problem, is hardly convincing. The fact that a difference between 2 and 12 per cent for the cost of lifts is disclosed suggests that there is scope for economy. Our research on the lines referred to shows that careful planning of access and lifts saves appreciably in the cost per flat and lowers rents.

What are the steps to bring down high costs? Various solutions are suggested in the papers, including

1. Planning more economically.
2. Using more maisonettes in preference to flats. Strongly advocated, not only by several architects, but also by both Mr. Dunican and Mr. Samuely.
3. Employing cross-wall construction as being less expensive than front and back, loaded walls, and more suitable for the operation of mechanised site plant, including the tower crane.

Again, asked Mr. Forshaw, should the methods and practices of America and the Continent be followed, especially complete pre-planning? Mr. Mitchell had fully described the advantages of pre-planning from the point of view of the contractor, and had answered very competently the critics of the building industry and demolished the charge that high costs were due to obsolete methods, but he had not made clear to whom the financial benefits of his achievements accrued. Mr. Dunican had gone even further than Mr. Mitchell in advocating pre-tender collaboration between architect and contractor, and that specialised work in high blocks should be the responsibility of architect, quantity surveyor, engineer and contractor working as a team. He had not made it clear, however, whether he proposed that the contractor should be engaged solely as a consultant or as consultant and builder at the same time.

How, asked Mr. Forshaw, was this pre-planning to be achieved? Would a new tender and contract procedure have to be adopted? How could the client's interest still be safeguarded if competitive conditions were eliminated? He thought it might suffice if the architect collaborated with the engineer and contractor at the pre-contract stage to ensure maximum constructional efficiency and to obviate subsequent revisions.

Finally, Mr. Forshaw referred to Miss Willis's paper, to which, he said, he had made insufficient reference. Her survey had provided the essential user reaction. Miss Willis had recorded the tenants' pleasure in living in high flats, but he did not really know whether we should be pleased or disturbed, in view of her statement that two out of three people would move into a house and garden if they could.

Mr. Forshaw concluded: I must close. I am sure the authors today are never allowed by the great authorities they serve to forget the tenant or indeed the ratepayer, and we must keep the knowledge of this responsibility in our minds all the time.

DISCUSSION

The Chairman said that Sir George Pepler had handed in the following question: 'Major Jensen based his argument for high densities largely on the saving of agricultural land, despite the fact that the Minister's own research department has demonstrated that the gardens of houses at not more than 12 to the acre produce more valuable food per acre than does average agricultural land. (See articles in MANCHESTER GUARDIAN and ECONOMIST.)'

Major Jensen said he did not think that there was much need to add to what was said in his paper. He did not take very seriously this sample survey, which appeared to show something which was at variance with the facts as a whole. He had no statistics with which to confound this research group, but to his mind this was one of the largest red herrings which had been drawn across the trail.

Mr. J. Stillman [*A*]: Mr. Cleeve Barr's remarks about ventilating internal bathrooms and w.c.'s in maisonette blocks of the Hackney type may give a slightly wrong impression. We have had a little experience of this and find that we are faced with certain bye-laws which prescribe separate extracts for the bath and w.c. and also separate fresh air inlets. There seems to be some doubt whether or not the London sanitary bye-laws allow internal bathrooms at all, or whether this matter is at the discretion of the medical officer of health of the borough.

It has been said several times to-day that maisonettes are popular, and to get a compact block with minimum wall area the cross-over maisonette type recommended by the Ministry of Housing seems to provide a solution. Now that only the one staircase is required, in blocks of under 80 ft. at any rate, they seem to be quite economic in access. It is in connection with such a block that we have come across these bye-law difficulties.

Mr. Cleeve Barr: The public health bye-laws which govern w.c.'s do permit mechanical ventilation. In London the public health bye-laws are made by the L.C.C. but administered by the borough councils. The position is somewhat delicate, to say the least, in the case of many borough councils who are meeting these proposals for the first time. In certain boroughs these matters are now under discussion between the medical officer of the council and the medical officers of the boroughs concerned. The L.C.C. bye-laws are under revision, but it may take twelve months or more for the revisions to become law, and they may be subject to all kinds of amendment. In the meantime, the position is that in London the borough council is solely charged with their administration.

Mr. R. A. H. Livett, O.B.E. [*A*] (City Architect, Leeds): Mr. Sheppard Fidler gave a most excellent paper, and I was very pleased indeed to find that I had in him a supporter of the Garchey system. I can claim to have brought the Garchey system to this country. I have the feeling that many people may go away with the idea that if the Garchey system is used the tenants will have to pay twice. That need not be so. In Leeds, where we have what I believe to be the largest Garchey plant in this country, the tenants on the estate concerned get a rebate from the cleansing department and do not pay for the ordinary door-to-door collection which is made by the cleansing authority.

Reference has been made to the shunt flue, and it may be of interest to mention that what London is about to do in this direction Leeds did in 1937, when we put in shunt flues as an experiment. I shall not say more about that than that we have since taken them out.

Mr. J. Austen Bent [*A*] (Scottish Special Housing Association): I was interested to learn that in Mr. Dunican's opinion five storeys represent the limit for no-fines concrete cross walls without a frame. My association is in the fortunate position of being able to employ its own team of architect, engineer, quantity surveyor and builder. We are working at present with a German consultant who was the engineer for the scheme referred to by Mr. Dunican, and we have on the drawing-board drawings for 10-storey tower blocks of flats in no-fines concrete without a frame.

Miss Willis made no reference to the very vexed question—as it seems to be, from questionnaires which I recently issued to English and Scottish authorities—of the success or lack of success of laundries in blocks of flats. Reading the recent publication *Living in Flats*, it would seem that the members of the committee concerned have divided views on the subject, and finally they express the opinion that small laundries serving 15 to 20 flats seem to be the best. Could Miss Willis please give her experience of small laundries?

Mr. Geoffrey Wood: I think that the answer to the first of these questions is that anything can be done if it is designed properly. I do not see why no-fines concrete should not be used for higher buildings if the stresses allow it. I believe that the Germans use higher stresses than we do in this country, but there is no reason why we should not put our stresses up.

Mr. Forshaw refers to the argument between competition and the selection of contractors before the contract. I think that the English compromise would be to have both, competitive and pre-selected. Pre-selection is extremely valuable where you are trying out a new process, which means that there is an element of risk. If you put the job out to competitive tender you have to pay for that risk; on the other hand, if you are prepared to take the risk yourself you can select the contractor on a cost-plus basis, with suitable safeguards, and then if you have confidence in your own design you find out what it costs and thereby establish the actual cost of a new process. Once that is established it is reasonably safe to go out to tender, because the contractors then know more or less what the job costs.

Miss Margaret Willis: I have done some research with regard to communal laundries for all flats, not just high ones, and it is a fact that the larger communal laundries are not very popular. The smaller type, where one woman goes and does her washing on her own, is more popular. That is partly because the women say that in the larger laundries there is too much gossiping, and when machines are damaged they do not know whom to blame. Drying cabinets in the flats are popular, because then the women can do the washing when they like. A mother with young children has washing to do every day. There is also the problem of going to the laundry and leaving young children in the flat. I think that that is why the L.C.C. have taken up the idea of home washing.

Major Jensen confirmed Miss Willis's statements. Gas-heated drying cabinets cost more and some people objected to steam from washing in their kitchens, but he thought these difficulties exaggerated. In France they used naturally ventilated enclosures for drying, usually adjoining balconies, which were inexpensive and satisfactory. He had found that communal laundries were not used unless an inclusive compulsory charge was made to the tenants; otherwise the capital cost of equipment was a bad investment.

Mr. Cleeve Barr: We knew about Mr. Livett's experiments with shunt flues in 1937, and with his kind permission I went over his flats in Leeds together with the people who supplied the units. It is unfortunate that, being a pioneer at that time, he had to accept failure. Shunt flues had been introduced in Belgium only in 1936. Since that date, however, and particularly since the war, a considerable amount of research has been done on them by the Dutch and French Building Research Stations, and a number of principles and rules, which in France are enacted by Government regulation, now condition their use. It was unfortunate that that knowledge was not available in 1937, and the lack of it accounts for Mr. Livett having to take them out.

Mr. G. D. Nash [*A*] (B.R.S.): On the Continent, shunt flues have been used largely with closed appliances. In English conditions, however, the open fire will be much more common, and we have to cater for that in terms of the effective pull of the flue. We may often have to cope in this country, moreover, with a different temperature condition between the inside and the outside of the building. The English use of the shunt flue, therefore, is a problem which has not been fully explored. With our open fires and our habit of opening the windows, even in the winter, the indoor temperature may be lower than the outdoor, and there may be a number of precautions to be taken. It is not possible to extrapolate straight from Continental experience.

Mr. E. A. H. MacDonald [*A*]: We have heard nothing about the provisions which are being made, in the design of these high

blocks, for maintenance. The cost of maintenance will go up considerably if proper provision is not made to facilitate painting and other maintenance work. What research has been done into that?

Mr. Whitfield Lewis: We make provision for cradles by permanent eyebolts cast into the concrete roof slabs. Up to a point it is possible to re-glaze at least our pivoted windows from inside. We are including internal glazing throughout with tall blocks, but it has repercussions on the capital cost. We have not made any particular advance towards better quality materials—aluminium windows and so on—purely on the question of capital cost.

Mr. H. T. Weeks: I was in the U.S.A. last autumn and obtained a number of detailed cost figures from the New York City housing authority. There were three things of great interest. First, the average cost of their flats at the present time is about £3,000. When we compare that with a figure of £2,200 here we have to remember that in the United States cement and steel are 50 per cent more expensive than they are here, and that American building labour is paid between 25*s.* and 30*s.* per hour.

Secondly, over a period of time when building costs in general in the United States have risen by about 20 per cent, the cost of these flats has remained almost steady. In other words, comparative economy has been secured over the last five years.

Thirdly, on the question of height, although the correlation is not very close it is a fact that, taking buildings of 3, 7, 8, 13 and 15 storeys the general relationship is that the higher the building the less the cost per flat—not by very much, but there is a definite relationship.

Mr. A. Steele [*A*] (City Architect's Department, Edinburgh): In Central Scotland, Dr. Weston's team were surprised to find that 3- and 4-storey flats cost less than cottage houses, and have done so for decades. That is purely because the contractors in that area are accustomed to that form of building. I submit that there is no reason at all why we should not produce high flats at a cost equivalent to that of cottages. We have not approached that yet in Central Scotland, but we have tenders for 3-room flats in blocks with two staircases, two lifts and a playground at under £1,800 and we hope to improve on that. While therefore contractors may be very slick at suggesting that their methods will bring about an improvement, they have a long way to go, and their opposite numbers north of the Border could teach them a thing or two about slick building.

Mr. Mitchell: I have a fairly good knowledge of building practice in Scotland. I think that sometimes their standards are a little lower than ours in the south, and that accounts for part of the reduction in the cost, but by no means for all of it. As I point out in my paper, we contractors have all a lot to learn. We do not claim that we have very great experience. I am certain that today I know a lot more than I did a year ago, when I thought that I knew.

Major Jensen: I think it is presumptuous to intervene in discussions on cost unless one has given the subject a considerable amount of thought. We are only beginning to realise some of the problems in the cost of very high buildings. The Germans have done a considerable amount of research into the question, and the best information that I have been able to find anywhere has been produced by the Building Institute in Hanover. It shows conclusively that between three and twelve storeys at any rate there is a progressive falling off in cost. It is very slight, but it is quite definite, and the information has been arrived at as a result of the investigation of a very large number of examples.

The almost universal experience in Western Europe is that the cost of flats is running at an equivalent in sterling of about £1,250. The explanation which is sometimes advanced, therefore, that flats and houses are not dissimilar in cost because houses on the Continent are expensive is not borne out in fact. There is every prospect that with the sort of organisation which is being used on high buildings abroad the cost will be brought down, and in fact we just have to get it down.

Mr. J. A. Farquhar [*A*] said that collaboration between the professions and industry needed to be taken further than design and construction of an individual building. For instance, the cost of moving a tower crane from block to block would be realised. Economies could therefore be made in the relation of blocks to one another.

The Chairman in closing the meeting said that a full report of the symposium would be published. He thanked the speakers, the Science Committee who had organised it and the R.I.B.A. staff responsible.

Practice Notes

Edited by Charles Woodward [*A*]

MINISTRY OF HOUSING AND LOCAL GOVERNMENT. First Five Year Review of Development Plans. The Minister of Housing and Local Government has issued a circular to local planning authorities giving advice on the first review of their development plans and setting out what fresh material he would like to have submitted to him on this occasion.

This review is due to take place five years after the approval of each individual plan; it was one of the provisions of the Town and Country Planning Act 1947, which aimed at making development plans less rigid than the older planning schemes.

The Minister does not consider that the plans should be extended on the occasion of this review; he advises rather that authorities should take the opportunity to concentrate in detail on problems of particular difficulty in their area and on subjects which they were not able to tackle fully on the first submission of the plan. He suggests that the submission should be a fairly short and workmanlike document reviewing the plan in the light of experience over the first five years, and drawing on that experience. Advice is given against the making of too many minor and meticulous amendments to the approved plans. A particular problem to which the Minister has drawn attention is that of the overspill of population from one area to another and he asked for information which will enable development plans for 'exporting' and 'receiving' authorities to be more closely linked.

The Circular is 9/55 dated 2 March 1955, and is obtainable from H.M. Stationery Office, price 6d. net.

DEFENCE REGULATION 56A. Destruction of Licensing Papers. Circular 21/55 dated 17 March addressed to housing authorities in England states that the destruction of official documents shall be as follows: In work not exceeding £2,000 in value, papers are to be retained for not less than 2 years from the date of the licence. In work exceeding £2,000, papers are to be retained for not less than 5 years from the date of the issue of the last licence if more than one. Copies of building licences issued by the Ministry of Works are to be retained for not less than 6 months from the date of the licence. Where applications for a licence were refused, the papers are to be retained for not less than 1 year from the date of refusal, or where further correspondence took place, from the date of the last letter.

HEATING, VENTILATING AND DOMESTIC ENGINEERING WORK. Daywork Charges. The terms of the agreement for 1955 and 1956 between the Ministry of Works and the Association of Heating, Ventilating and Domestic Engineering Employers has been accepted and approved by the Quantity Surveyors Committee of the R.I.C.S. The agreement covers the period between 1 January 1955 and 31 December 1956. Although the scope of the agreement remains the same as in previous years the wording has been re-arranged and the percentages amended. Copies of the agreement may be obtained from the R.I.C.S., price 3d. post free.

SMOKE ABATEMENT IN THE CITY OF LONDON. The Common Council of the City of London are recommended to exercise their powers under the City of London (Various Powers) Act 1954 which deals with prohibition of emission of smoke in the City. It is proposed that the provisions of the Act should come into operation on 2 October 1955.

The Act specifies coke and anthracite as 'authorised' fuel and the Common Council are recommended to approve Welsh dry

steam coal, phurnacite, coalite and rexco in addition.

The Act states the penalty for non-compliance and also the defences which are available in any proceedings.

HOUSING ACT 1936. Houses unfit for human habitation. Under section 9 of this Act a local authority may require work to be executed to a house so as to make it fit for human habitation. The section refers to any house which is 'occupied, or is of a type suitable for occupation, by persons of the working class'. The term 'working class' was, however, repealed by the Housing Act 1949 and the words 'in any respect' which occur in section 9 of the 1936 Act were repealed by the Housing Repairs and Rents Act 1954. There would therefore appear to be no qualification of the 'unfitness' of a house for any special class of persons. In a recent case where the local authority had served a notice requiring work to be done to make the house fit for human habitation, the Judge deleted some items from the notice and allowed others. Amongst the latter was an item for making a door stay shut where it is necessary for normal use.

The case is reported in THE ESTATES GAZETTE for 19 March, where the tests to be applied in regard to 'unfitness' are discussed and the effect of section 9 of the 1936 Act as amended by the 1954 Act is referred to. Section 9 of the latter Act gives the matters to be taken into consideration in deciding whether a house is unfit for human habitation under the provisions of the 1936 Act.

PAYMENTS UNDER THE TOWN AND COUNTRY PLANNING ACT 1954. Closing Dates for Submitting Claims. Persons who hold claims on the £300 million fund under the Town and Country Planning Act 1947 have until 30 April to apply to the Central Land Board for any payment to which they may be entitled. The Board have already received over 36,000 applications, but it is believed that many others are outstanding.

The most important cases where a payment may be due are: (i) where development charge has been paid on the land covered by the claim; (ii) where the land concerned was sold or leased for less than its full value to a public authority before 1 January 1955, or privately before 18 November 1952; (iii) where the land was given away before 18 November 1952; (iv) where the claim was purchased before 18 November 1952 and has been owned separately from the land.

Persons who do not hold claims on the £300 million may also qualify under (i) or (ii) if they bought land in respect of which a claim had been made.

The Central Land Board have sent forms of application for payment to claim holders whom they have been able to identify as having paid a development charge or as having sold their land to a public authority, but anyone who thinks he is entitled to a payment for any event which occurred before 1 January 1955 other than a planning restriction (see below) and has not received an application form should write to the Board for one without delay.

Planning Restrictions. Claim holders who have been refused permission to develop their land or have had onerous conditions imposed on a grant of planning permission may be entitled to a payment from the Ministry of Housing and Local Government. The closing date for applying is 30 June if the planning decision was given before the end of last year. Forms of application can be obtained from any local authority.

To help those who believe they may be entitled to compensation, the Ministry of Housing and Local Government has produced a 6d. booklet 'Town and Country Planning Act, 1954—How to Claim Payments—A Guide for Owners of Land' obtainable from H.M. Stationery Office, or through any bookseller.

LAW CASES. Odder v. Westbourne Park Building Society. It was decided in this case that where a Building Society's surveyor makes a report for the purpose of a mortgage, the Society owes no duty to the borrower to warn him if the survey is not satisfactory. Therefore, there is no negligence for which the Society could be made liable. Judgment was given for the Society with costs. (THE ESTATES GAZETTE, 5 March 1955.)

R. v. Minister of Housing and Local Government, Ex Parte Finchley Borough Council. A Divisional Court of the Queen's Bench Division decided that where a memorial was addressed to the Minister under section 268 of the Public Health Act 1875 he had the widest possible powers to decide what was equitable, which meant fair and reasonable, and that there were no words in the section which limited his powers as to what he might inquire into or limited the grounds on which he might allow or disallow an appeal. Decisions on points of law were not excluded from the purview of the Minister.

The case concerned the proportionate amount of expenses incurred by the Council in making up streets and claimed from frontagers; and in the circumstances of the case the Minister had ordered that no amount was payable. It was from this decision that the Council appealed. (1955, 1 All E.R. 69.)

Surveyors' Report on a House. Dry Rot. In a recent case where judgment was given against surveyors for failure to give a warning as to dry rot in a house upon which they were reporting for a purchaser, the Judge said that he had to determine whether, at the time of the survey, there was evidence of dry rot which ought to have been observed by a prudent surveyor or, alternatively, whether there was evidence of the possibility of dry rot which a prudent surveyor should have reported upon in his report after his examination. Admittedly no such warning was given in the report, but on the other hand the person to whom the report was made was well entitled to believe that nothing had been observed in the survey which would indicate the possibility of his being put to any substantial expense for repairs due to dry rot, either at all or for many years. (THE ESTATES GAZETTE, 26 February 1955.)

Claim against architects for breach of contract. In a recent case in the Court of Appeal, the Court said that in negligently giving a certificate for an amount more than was due the architects were guilty of breach of contract, and when the Court finds a breach of duty it will not allow architects to get a penny of their fees and will make them compensate their client for all the expenses due to their fault. (THE ESTATES GAZETTE, 26 March 1955.)

Correspondence

The Editor, R.I.B.A. Journal.

SYMPOSIUM ON HIGH FLATS

SIR,—It may be an interesting point for debate whether it is cheaper to house families in a New Town at low density or in high flats at high density. The gap disclosed in a comparison between (*a*) the net costs, which include for land, buildings and all necessary services, narrows when the comparison is made between (*b*) the gross costs, which include for all consequential expenditure.

In the March issue of the JOURNAL Major Jensen is reported as having stated that the recent New Towns Report showed the average cost per dwelling at Bracknell was £4,700. This rather extraordinary figure was apparently arrived at by dividing the total expenditure of £2,008,000, taken from a one-line extract from the official accounts, by the number of houses completed on 31 March 1954. Some of the items included in this expenditure should have been excluded in arriving at the net cost of the dwellings; other items should have been added in any attempt to assess the gross cost at this early stage of development. The value of the deduction was still further reduced because Major Jensen divided an unrelated total expenditure by the number of houses completed by 31 March and omitted to make any allowance for the 654 houses then in various stages of construction, payment for which was included in this expenditure.

I only trouble you with this letter because a half truth can be doubly misleading and because, when growing interest is being shown in New Town Development at home and abroad, it is desirable that statements made at important conferences should be correct.

Yours faithfully,

L. H. KEAY,

Chairman, Bracknell Development Corporation.

Architectural Education Two Hundred Years Ago

By Peter Collins [*A*], Membre Correspondant, S.A.D.G.

THE MINUTES OF learned societies are not usually recommended as entertaining literature. In fact one may wonder whether anyone ever reads them at all, once the chairman has appended his signature. It is surprising therefore to find in the minutes of the French *Académie Royale d'Architecture* a charm, simplicity and elegance which give life to the subject-matter of their deliberations, and an unhurried dignity which at times, as in the 'de Wailly affair', attains a real dramatic intensity.

Some of the most interesting entries concern the Academy school, which was founded at the same time as the Academy in 1671. Many features of architectural education of the period have continued unchanged to the present day. There were, however, marked differences; the 18th century student was, for example, undoubtedly more unruly than his present-day counterpart. It is unlikely that nowadays one would find a regulation similar to that of 1762 whereby 'students are expressly forbidden to walk about on the entablature' during examinations. The entablature referred to crowned the lower storey of the Louvre, and it was on the first floor of this building that the *Grand Prix* competition was held. Whilst a benevolent academician sat invigilating in the middle of the hall to see that no one entered the students' *loges*, friends circulated freely along the face of the building to give a helping hand with the rendering. To avoid discovery, the competitors brought hasps and padlocks and surreptitiously fixed them to their doors.

The system officially laid down for preparing schemes was then very much the same as that in force at the *École des Beaux Arts* today. There was the annual *Prix de Rome*, inaugurated as a regular event in 1720, and monthly projects intended to prepare for the *Prix de Rome*, inaugurated in 1763. To avoid cheating, the academicians met at eight o'clock on the morning of the competition to decide the subject. The Professor dictated the programme immediately afterwards to the students so that they 'could work on it and do their esquisses without being able to consult anyone who might aid them.' Trouble was occasionally caused by enthusiastic young architects trying to gatecrash. Only the official students of the Academy school were allowed to attempt the Rome Esquisse, but their less fortunate comrades made determined efforts to gain the coveted prize. On 4 May 1761 the Academy decided that no one should be allowed into the examination room unless he could produce a letter from an academician certifying him as his pupil.

Then, as now, the final drawings as well as the esquisses for the *Prix de Rome* were rendered *en loge*. Occasionally scandals occurred, in spite of the fact that the Academy 'advised the students to behave themselves in the *loges*, and not to interrupt their comrades in their work'. 'Every year the Academy receives complaints from students and accusations against those who were most successful. With the desire to prevent all irregularities as best it can, it declares that those who admit any person whomsoever to their *loges*, whether a colleague or not, shall be completely disqualified.' In 1759 three competitors were disqualified for openly taking their drawings away to render them at home. One of them, Heurtier, continued undaunted to compete each year until he finally won the prize in 1765, and eventually became Inspector of the Royal Buildings at Versailles.

The monthly programmes were usually less pretentious than those for the *Grand Prix*, and by 1775 a syllabus had been laid down whereby there were to be eight programmes of architectural composition, two of architectural ornament, and two of perspective or construction. This syllabus was included in the Academy's Statutes, signed by the King himself, and 'sealed with the great seal in yellow wax'. Incidentally, it may be noted that this Statute included the provision that students who could show certificates of good attendance might be exempt from military service.

Sometimes the monthly projects were so bad that no prize was awarded. On at least two occasions there was only one entry. Once, the students disliked the programme so much that they marched out of the studio en masse, to the consternation of their professor.

The *Grand Prix* programmes were sometimes rather sumptuous, and might bear the stipulation that the building should be suitable for 'a prince of the royal blood' or 'a nobleman of high degree'. In 1756, for example, the subject was 'A Menagerie for a Sovereign Prince'. In 1769 it was 'A Public Festival, the theme of which shall be the Temple of Hymen for a Prince's Wedding'. In 1773 it was for a garden pavilion which 'will just be used for private parties given by the Sovereign'. Usually, however, the programmes were of the type we should expect today: a parish church (1760), a concert hall (1761), a covered market (1762), a school (1764), a customs house (1767).

The covered market was, like many of the programmes, of topical interest, because the market of St. Germain had been burnt down two months previously. In this scheme, it may be noted that the students were forbidden to make use of the classical orders. Industrial subjects were not unknown; in 1770, the programme was entitled 'An Arsenal', and included the necessary workshops for manufacturing arms and cannon. One of the more delightful programmes was 'A Bathroom at the bottom of a Garden'.

We do not know the standards by which the schemes were judged, apart from our general knowledge of the standards of the age, and those prize-drawings of the period which are still in existence. It is interesting to note, however, that in 1756 none of the esquisses were admitted by the King's Minister, Marigny, who wrote complaining that there 'is not one of them could not be put to other use than a Menagerie. I think the programme given was too broad and too complicated, which confused the students . . . it being impossible that young men may suddenly give birth to ideas, the details of which require knowledge which one is always obliged to borrow from others.' In 1765 not one of the thirty esquisses was accepted because, amongst other reasons, 'several students had too little relationship between their plans and elevations'.

The final day of judgement was a great occasion. The King's Minister honoured the jury with his presence, and then distributed the medals to the three lucky winners. The first prize was a gold medal and three years in Rome; the second prize was a 'large' silver medal; the 'second second prize' was just an ordinary silver medal. All these medals were stock articles from the Royal Mint, usually with an architectural subject, such as a new building or bridge, on the reverse. The obverse bore the portrait of the royal donor.

In addition to exercises in design, lectures were given by the professor of architecture and the professor of mathematics, who each lectured for two hours on two mornings a week during term. When Jacques-François Blondel was professor he obviously took his work very seriously, and once asked if he could borrow seventeen volumes all at once. As this represented almost the entire library of the Academy, the academicians were not very enthusiastic. 'The Academy, having approved the use which M. Blondel proposes to make of these seventeen volumes, ordered that the secretary should hand them over to be kept in the cupboard to which the Professor of Architecture has the key, on condition that he returns them to the secretary's cupboard at the first demand of the Academy, and on condition also that these seventeen volumes do not leave the Academy's rooms, and remain in the cupboard to which M. Blondel has the key.'

However, in spite of being so well prepared, the lectures do not always appear to have been well attended. In 1770 the Academy sternly asked Blondel to provide a list of those who absented themselves regularly so that they could be officially reprimanded. Failure to attend lectures regularly disqualified students from participating in the competition for the *Prix de Rome*. The Academicians were always complaining that the students were lazy; the students were always complaining that they had not enough time to finish their

schemes. In this they were usually supported by Blondel, who proved a soft-hearted task-master. 'On the good witness their professor gives of their hard work since the beginning of the competition, and without prejudice to any future occasion, the students may take down their drawings in order to finish them in their *loges*.'

In 1772 the students complained that their *loges* were so small that they were unable to use the size of board required, and asked to be allowed to draw their plans to a smaller scale. The scales used are not without interest, since it is very likely that the regular use of common scales was an invention of the school. In those days, an architect drew a building so that it was just big enough to fit the piece of paper, preparing an arbitrary scale-line by means of dividers. When the Academy started assessing students' competition drawings, it became necessary for all the drawings to be to the same scale, and in 1701 we find a scale specified for the first time. The fractions used were by no means standardised, and were often very complex, being usually fractions of twelfths of an inch per six feet.

The finished drawings were supposed to be kept by the school, but in this, as in everything else, the students were not very obedient. On 18 January 1773 'M. Blondel, professor, made representations that, some of the students having asked for their drawings back on the pretext of copying them, they have not handed them in again, and he begged the Academy to decide what he should do'.

Yet in spite of such complaints, Blondel must have been as proud of his pupils as he was fond of them. Unruly indeed they were, but it was the spirit of the age, and revolution was already in the air. It is in no small measure due to these men that Paris is the most beautiful city in the world, and much of the credit must go to the institution and tradition which fostered their architectural education.

Book Reviews

The Town and Country Planning Act 1954 together with the Town and Country Planning Act 1953, by *Derek Walker-Smith* and *Lewis F. Sturge* in collaboration with *Alistair Dawson*. 9½ in. [xviii] + 222 pp. Eyre & Spottiswoode. 1955. £2.

The Town and Country Planning Act 1953, in four sections, dealt with the abolition of the three-hundred-million-pound fund originally set up to compensate would-be developers whose aspirations were frustrated by the Planning Authorities. The 1954 Act (which came into force on 1 January 1955) deals principally with what is to happen now that the original scheme for compensation has been abolished.

The provisions of this latter Act are lengthy, intricate and often involve highly artificial concepts, so that this brief and clear exposition of the subject is most welcome to those whose work entails advising on matters of financial moment in relation to land. Its value is enhanced by reason of the speed with which it follows on the heels of the Act.

The text of both Acts is printed in full with explanatory notes to the sections of each by the authors, indicating briefly the object of the section and, where necessary, a reference to other relevant provisions. This naturally does not give the whole in great coherence, but the Notes are aptly linked by a general commentary of eighteen pages which precedes the annotated texts.

In addition to the usual difficulties experienced when construing Acts of Parliament, the 1954 Act abounds in technical phrases invented for the purposes of the Act, and it is a matter for relief to the reader and congratulation to the authors that they have provided a glossary of statutory terms. This glossary gives the meanings to be attributed to the term and the statutory authority for the interpretation.

Regulations made under the Act are of course of importance and those which so far have been made are set out in Appendix II.

The publishers ask that attention be drawn to an omission from the text of the Schedule printed on page 196 of the book, the missing paragraphs of which can be supplied by the publishers on request; but if preferred, the full text of the claim form is obtainable in the actual form supplied by Local Authorities. D. R. P.

Prestressed Concrete by *Gustave Magnel*. (Concrete series.) 3rd ed. 9 in. vi + 345 pp. incl. pp. of illus. text illus. Concrete Publications. 1954. £1.

A rapidly advancing subject is brought further up-to-date with this revised and enlarged edition. Probably the chapters of most interest to architects will be the first, on general principles, and the last but one, which gives examples of prestressed concrete structures.

Reinforced Concrete Arch Design, etc., by *G. P. Manning*. 2nd ed. 8½ in. xii + 192 pp. + 4 pp. of illus. text diag. Pitman. 1954. £1 10*s*.

This is a new edition of a book first published in 1933 and is intended to assist designers of small and medium span bridges and advanced engineering students.

Misericords. Medieval Life in English Woodcarving, by *M[ary] D. Anderson*. (The King Penguin books, 72.) 7 in. 32 pp. + 48 pls. Harmondsworth: Penguin Books. 1954. 3s. 6d.

This is the first general work (to one's knowledge) on this subject—a favourite one with ecclesiologists and iconographers—since Francis Bond's standard book (1910). The author, who has produced several manuals on the subject-matter of English craftsmanship since 1935, furnishes a text from this and also more general standpoints, which serves as a running commentary on the plates, instead of separate notes. Criteria for dating are explained. Examples in nearly thirty different buildings are illustrated.

Scottish Country Houses and Gardens Open to the Public, by *John Fleming*. 11¼ in. × 8¾ in. 128 pp. incl. pls. and pp. of illus. + front. text illus. Country Life. 1954. £1 5*s*.

Although several works exist on accessible English houses, besides the well-known annual of the Queen's Institute of District Nursing, no one hitherto seems to have thought fit to publicise Scottish mansions. Over thirty examples are here well shown, with learned texts: castles from the 14th century or earlier to the 1590's, border or 'peel' towers of the 15th and 16th, a royal palace of the early 16th, and houses, including mock castles, from about 1620 to 1822, with several lovely gardens. There is a good index, differentiating main references and illustrations.

H. V. M. R.

The Story of Architecture in Mexico, *&c.*, by *Trent Elwood Sanford*. 9¼ in. xviii + 363 pp. incl. pls. (maps) + lxiv pls. and pp. of illus. Vision Press. £2 2*s*.

Recent Mexican work, notably the great new University complex, provides a striking example of the development of modern architecture away from the inadequacies of doctrinaire functionalism. Regionalism and a profound awareness of national tradition have combined with the universal truths of the Modern Movement in a vital and robust expression of the *genius loci* of a country, its people and their aspirations. Any mature assessment of these new achievements must be based upon a knowledge and understanding of the history and traditions underlying them.

Mr. Sanford's volume is a well-written introduction to such knowledge and understanding. It would be difficult to write a dull book about the civilisations of the Mayas, the Toltecs and the Aztecs, but this one—complete to the advent of functionalism—is deserving of more positive praise. In achieving his difficult aim of writing a book of equal interest to the general reader and the student of architecture the author avoids the twin pitfalls of technical jargon and mere guide-book description. If, at times, the accounts of legend seem to outweigh the purely architectural content, such accounts are rarely irrelevant and always illustrate the great complexity of the web of influences that play their part in the development of great architecture.

The photographic illustrations are adequate, but the drawn maps are deplorable. The appendices are useful and include a glossary of Spanish and Mexican terms, a good bibliography and a thorough and accurate index. GORDON GRAHAM [A]

Review of Construction and Materials

This section gives technical and general information. The following bodies deal with specialised branches of research and will willingly answer inquiries.

The Director, The Building Research Station, Garston, near Watford, Herts. Telephone: Garston 2246.

The Officer-in-charge, The Building Research Station Scottish Laboratory, Thorntonhall, near Glasgow. Telephone: Busby 1171.

The Director, The Forest Products Research Laboratory, Princes Risborough, Bucks. Telephone: Princes Risborough 101

The Director, The British Standards Institution, 2 *Park Street, London, W.*1. *Telephone: Mayfair* 9000.

The Director, The Building Centre, 26 *Store Street, Tottenham Court Road, London, W.C.*1. *Telephone: Museum* 5400 *(*10 *lines).*

The Director, The Scottish Building Centre, 425–7 *Sauchiehall Street, Glasgow, C.*2. *Telephone: Douglas* 0372.

F.P.R.L. **Leaflets.** The Forest Products Research Laboratory have issued two leaflets, which may be obtained free from the Laboratory, at the address given in the heading to this Review. Leaflet No. 47, *The Movement of Timbers*, deals with the fluctuating dimensional changes in seasoned timber in service, when it is normally subjected to changes in atmospheric conditions, and for these changes the term *movement* is preferred to *working*.

It has been found that the shrinkage of wood in drying, and the subsequent movement of seasoned timber, are by no means directly related one to the other. The laboratory method of determining movement is then described, and the results of tests of a number of hardwoods and softwoods are given. These are followed by a list of timbers ranged in three classes; Class 1 names timbers with small movement values; Class 2 gives those of medium movement, and Class 3 those with large movement values. In Class 1 are placed those species in which the sum of the percentage radial and tangential movements (given in the results of tests) is less than 3·0 per cent. In Class 2 are put those timbers in which the sum is between 3·0 and 4·5; those in which the sum is over 4·5 per cent being placed in Class 3, but a warning is given that because a timber comes into the small movement class it does not necessarily mean that it will distort less in service than one in the medium or large class.

Leaflet No. 48, *Hardwoods for Industrial Flooring*, will be read with interest by all those who have to decide on a timber for an industrial floor. Studies of many hardwoods under abrasive action clearly show that the resistance of a wood surface to actual breakdown and disintegration is appreciably affected by its anatomical structure—the size, arrangement and distribution of the pores and the character of the grain, whether straight or interlocked—and to a less extent by its density.

The leaflet is illustrated with photomicrographs of transverse sections of certain hardwoods, and a table lists 29 woods, giving the name of their species, source of supply, weight, description, and comments on suitability for various industrial purposes.

The Heating of Churches. The Central Council for the Care of Churches have issued a technical review of this subject; it has been prepared because the many inquiries received by the Council showed that there was need for some publication to assist in elucidating a somewhat complex subject. The review deals only with the moderate-sized church, whether ancient or more recent.

The various systems of heating are explained in purposely non-technical language, and special warnings are given against disfigurement of churches by awkwardly placed heating units.

Although the review states that it is impossible to give the cost of heating churches by the various methods described, because so many factors have to be taken into consideration, two tables are given which are of interest as they are based on information extracted from questionnaires completed by those who were satisfied with the heating system in their churches. The first table gives the capital costs of heating installations, gas heating by luminous radiant panels being given as unity for comparison purposes, electric tubular heaters being rated as 2, with other systems coming between.

In the table of running costs, low pressure hot water (coke fired) is rated at unity; other systems rising to low pressure hot water (gas fired) at 2·10. No allowance for builder's work has been included in these figures.

The title of the review is *The Heating of Churches*; it can be obtained from THE BUILDER, Catherine Street, London, W.C.2, price 2*s*. 6*d*.

The Prevention of Corrosion. The British Iron and Steel Research Association have published a booklet dealing with corrosion of iron or steel in air, in water or in soil. The booklet states that 'It has been clearly shown that corrosion will not take place in an atmosphere with a relative humidity of less than 70 per cent, and that where the relative humidity is conducive to corrosion the degree of atmospheric pollution is the governing factor'.

Cathodic protection is simply explained. 'Corrosion is an electrochemical process involving an anode which is corroded, and a cathode, which is not. Let us, therefore, so arrange matters that the metal that we wish to protect acts as a cathode, i.e. is the uncorroded member of the electrolytic cell. In essentials, therefore, cathodic protection consists in making the steel the protected part of a suitable electric circuit so as to throw the corrosion from it on to a "sacrificial anode".'

Various protective treatments are described in the booklet, which may be obtained from the B.I.S.R. Association, 11 Park Lane, London, W.1, price 2*s*.

Specifile. In the March 1953 issue of the JOURNAL an advance notice was published of a new filing system then in course of preparation; it has now been produced under the name Specifile and covers building materials and services. A leather-bound case with filing prongs is supplied, complete with indexed manilla sheets on which the main subject headings are printed down the right-hand side.

Into this folder punched information sheets can be inserted on the prongs; these sheets are supplied by the Specifile organisation and contain manufacturers' information, all being of the uniform size of 11 in. by $8\frac{1}{2}$ in., thus complying with B.S. 1311, 1946 and 1955, which deals with sizes and contents of manufacturers' trade and technical literature. The sheets are headed with the same wording as the indexed manilla sheets and they also have subdivision headings; for instance, on opening the folder at Paints and Finishes one finds information sheets sub-headed Exterior, Interior, Anti-corrosive, Lead based.

Included in the volume is a catalogue section alphabetically indexed, and here other literature from manufacturers can be filed in manilla pockets. There are also prepaid inquiry postcards on which the details required can be noted and the card posted to Specifile, who will endeavour to obtain the information and send it to the inquirer.

The subscription to Specifile is two guineas a year, for which subscribers receive cases as required and regular mailings of up-to-date information sheets, as well as the inquiry cards.

Specifile is part of the Industrial Mailing Services Organisation and inquiries should be addressed to Specifile, 81 Blackfriars Road, London, S.E.1 (WATerloo 5913).

Architects who hitherto have formed their own filing system, often of an unreliable nature and dependent on the whims of the filer, will appreciate a system which contains information sheets of uniform size, arranged under comprehensive main headings and sub-headings.

Plastering without Hacking. Messrs. J. Manger and Son Ltd., of 57d Kingsland High Street, London, E.8, announce a new material which they call Plastaweld. They state that it can be applied by brush or spray to painted work, smooth dense concrete, glazed bricks or tiles, metals, and smooth pointed brickwork. Messrs. Manger claim that this application permits all types of gypsum plaster to be applied without carrying out hacking or similar prepara-

tory work. They say that Plastaweld is not affected by heat or cold, humidity or dryness; that it does not deteriorate nor disintegrate with time; is non-toxic and vermin proof, and can be applied to damp walls.

The M.K. Gridswitch. At the recent Electrical Engineers' Exhibition at Earls Court there was a marked tendency towards simplification and interchangeability. Many of the exhibits, interesting though they were, may be considered to be somewhat outside an architect's concern, but in the range of switches and similar components there were several examples worthy of attention, and one of these was the MK Gridswitch.

In the Gridswitch range there are only three sizes of boxes, but in them one, two, three, four, six or eight switches can be accommodated. This is made possible by grid assemblies which fit into the respective boxes and carry varying numbers of switches; thus one box can take one or two switches; the second box can take three or four switches, and the third box six or eight switches, all with their corresponding cover plates. The A.C. switch movement is factory-sealed and does not need maintenance. As there is ample room in the box for stowing the cables the grid assemblies can be wired at a comfortable working distance from the box and then be put in place and screwed to the holding brackets. The grids can as easily be taken out and changed for another type.

These components are made by Messrs. MK Electric Ltd., of Wakefield Street, Edmonton, London, W.18.

An Ejector Plug. Three-pin plugs on the electrical circuit can sometimes be a little awkward to withdraw from their sockets, especially by persons whose hands are not very strong, and consequently the plug is waggled from side to side and tugged in the endeavour to ease it out, and this causes some strain on the pins and socket.

Messrs. Clang have produced a plug which off-sets the difficulty in a very simple way; the top of the plug is shaped to form a rim and in the centre is a plunger. To withdraw the plug the first and second fingers are placed round the neck of the plug, just under the rim, and the thumb depresses the plunger, which pushes the plug out and does away with pulling, tugging and waggling. It is called the Ejector Plug and is made by Messrs. Clang, Ltd., of Crown Yard, Cricklewood, London, N.W.2.

Timber Decay. Messrs. Richardson and Starling, of Winchester, announce that they have opened a Timber Decay Enquiry Bureau at 6 Southampton Place, London, W.C.1, telephone HOLborn 3555/6. The Bureau is for the convenience of architects and others in the London area, and specialists will be in attendance to deal with inquiries about all kinds of timber decay.

Messrs. Richardson and Starling are the manufacturers of Wykamol for eradicating wood borers, Reskol for dry rot, and other preparations for similar purposes.

International Federation of Prestressing. The second congress of F.I.P. (*Fédération Internationale de la Précontrainte*) will be held in Amsterdam from 29 August to 2 September.

Papers will be read on various aspects of prestressing, and technical visits will be organised to inspect bridges and buildings. A special ladies' committee will entertain wives and guests accompanying members of the congress.

Those interested in this congress should communicate with the secretary of the Prestressed Concrete Development Group, 52 Grosvenor Gardens, London, S.W.1.

Building Bulletin No. 10. The Ministry of Education have issued this bulletin, dated February 1955 and entitled *New School Playing Fields*. It deals mainly with the provision of playing fields and hard games areas on land adjoining new primary and secondary schools, especially the last, but most of the material applies to playing fields generally. It will be recalled that the minimum areas of playing fields for schools were revised in the 1954 Building Regulations, where the areas for most secondary schools were reduced.

The bulletin gives advice on educational requirements, choice of sites, layout and construction of playing fields, specifications, bills of quantities and costs, and maintenance. Appendices deal with minimum areas, soils and seeds, and specimen clauses for playing field specifications.

Diagrams suggest possible dispositions of playing fields adjoining a school, and they also give dimensions to which the layout for various games should conform.

The bulletin is published by H.M.S.O. Code number 27-291-10, price 3*s*. 6*d*. net.

Testing Concrete. Until recently the only way of determining the physical characteristics of concrete, and the changes brought about by ageing and other causes, was by preparing specimens and testing them to destruction. There was need for a non-destructive technique and this has been met by the Road Research Laboratory, who have devised ultrasonic equipment by which concrete can be tested, either in position on the job or elsewhere, using transducers placed on opposite sides of the concrete. Electrically-timed pulsations passing from one transducer to the other indicate the characteristics of the concrete and the presence of internal cracks.

Road Research Technical Paper No. 34, *Testing concrete by an ultrasonic pulse technique*, describes the method and its scope. The paper is published by H.M.S.O., price 2*s*. 6*d*. net.

Super Purity Aluminium. The British Aluminium Company Ltd., of Norfolk House, St. James's Square, London, S.W.1, have published a booklet on the uses of super purity aluminium. It contains technical information likely to be required by the plumbing contractor and his operatives, but an architect writing a specification could pick up some useful hints from the booklet.

Modular Catalogue: Correction. In the February 1955 issue of the JOURNAL an illustration of a typical sheet of the catalogue appeared; it was of Messrs. Broad's Broad–Acheson modular structural and partition block, and the cost was given as 'The blocks delivered London per yard super 10*s*. approx.' Messrs. Broad inform us that they inadvertently advised the Modular Society of this price, which should read 6*s*. and not 10*s*.

Solid Fuel Appliances. The Coal Utilisation Council have issued their List No. 10, January 1955, of recommended domestic solid fuel appliances; it cancels List No. 9 of July 1954 and has been prepared in consultation with the Ministry of Fuel and Power. The list can be obtained from the C.U.C., 3 Upper Belgrave Street, London, S.W.1.

Stains in Timber. The Timber Development Association have published their *Timber Information, Ref. No.* 44, ***Stains in*** *Timber*. It describes various types of stains and an appendix sets out in columns the type of stain, the cause, and remarks.

The pamphlet may be obtained, free, from the T.D.A., 21 College Hill, London, E.C.4.

British Standards Recently Published

B.S. 1415: 1955. **Mixing Valves (manually operated) for Ablutionary and Domestic Purposes.** This Standard does not deal with combined taps, its purpose being to provide minimum requirements for satisfactory operation and to ensure essential safeguards. Price 2*s*. 6*d*.

B.S. 2566: 1955. **Broad Flange Beams and Heavy Flange T-Bars and Long-Legged T-Bars.** This document standardises a number of sections developed primarily for use in welded steel construction, as it had become apparent that the previous range of B.S. rolled steel sections did not fully cover the requirements for such construction. It has been found that the most useful and economical sections are those now given in the Standard; other proposed sections being rejected for various reasons.

Diagrams illustrate the various members and tables give their properties. The method used for calculating the sectional properties is explained, as it differs from that used for the purpose in B.Ss. 4, 4A and 6. Price 2*s*. 6*d*. net.

B.S. 2569: 1955. **Sprayed Metal Coatings. Parts 1 and 2.** Part 1 deals with the protection of iron and steel against atmospheric corrosion, and applies to sprayed coatings of aluminium or zinc.

Part 2 deals with the protection of iron and steel by aluminium against corrosion at temperatures between 120 and 950 degrees C. The price of each part is 2*s*.

B.S. 2572: 1955. **Phenolic Laminated Sheet.** Specifies a number of types of phenolic laminated sheet and divides them into classes; A, with asbestos filler; F, with cotton fabric filler; P, with cellulose paper filler, and W, with wood veneer filler. Price 4*s*. net.

Notes and Notices

NOTICES

One Hundred and Seventeenth Annual General Meeting: Tuesday 3 May 1955 at 6 p.m. The One Hundred and Seventeenth Annual General Meeting will be held on Tuesday 3 May 1955 at 6 p.m. for the following purposes:—

To read the Minutes of the Sixth General Meeting held on 5 April 1955; formally to admit new members attending for the first time since their election.

To receive the Annual Report of the Council and Committees for the official year 1954–55. (Copies of the Annual Report were sent to members on 19 April.)

(*Note:* It will facilitate answers to questions if members will give the Secretary prior notice of any questions they may wish to ask. Notices should be in the Secretary's hands not later than 27 April. This will not preclude the right of members to ask questions on the Annual Report without having given prior notice.)

To nominate two members as Hon. Associates for the ensuing year.

(Light refreshments will be provided before the meeting.)

Eighth General Meeting: Tuesday 17 May 1955 at 6 p.m. The Eighth General Meeting of the Session 1954–55 will be held on Tuesday 17 May 1955 at 6 p.m. for the following purposes:—

To read the Minutes of the One Hundred and Seventeenth Annual General Meeting held on 3 May 1955; formally to admit new members attending for the first time since their election.

Professor Sir William Holford, M.A., M.T.P.I. [*F*], to read a paper on 'Conditions of Building in City Centres'.

(Light refreshments will be provided before the meeting.)

R.I.B.A. Reception: Friday 20 May 1955. The R.I.B.A. Reception will be held on Friday 20 May 1955 from 8.15 p.m. to midnight. Tickets price 15s. each may be obtained by members on application to the Secretary. Applications, which must be accompanied by the necessary remittance, should be made as soon as possible, as although no restriction is being made on the number of tickets each member may take, the list may have to be closed if there is an unusually large demand.

British Architects' Conference, Harrogate, 8–11 June 1955. All members and Students of the R.I.B.A. and the Allied and Associated Societies are cordially invited to attend the Conference. Full details of the programme and the application form were enclosed with the March issue of the JOURNAL. Application forms should be completed and sent to the Secretary R.I.B.A. as soon as possible but in any case *not later than* 16 *May*.

The list of hotels prepared by the Conference Executive Committee is included in the programme.

R.I.B.A. Kalendar. The 1955–56 issue of the Kalendar will be published in the autumn and the last day for receiving changes of address for inclusion in that issue will be 31 May. This date applies to *all* members and Students, both in the United Kingdom and overseas.

R.I.B.A. Conditions of Engagement and Scale of Professional Charges. With reference to the latest edition of the Scale of Professional Charges which came into operation on 1 June 1954, a graph has now been printed illustrating the sliding scale of fees applicable to New Works under Clause B.1 (ii), and a copy may be obtained on application to the Secretary, R.I.B.A.

The Practice Committee wish to emphasise that the document has been prepared solely for reference purposes in a member's office and not for wider distribution.

The opportunity is taken of reminding members of the necessity for bringing the Conditions of Engagement and Scale of Professional Charges to the notice of clients at the time of appointment so that there is a clear understanding at the outset as to the fees payable and the times of payment. In particular it should be noted that, under the terms of Clause B.2 of the Scale, the appropriate charge is essentially a matter for prior written agreement between client and architect.

CURRENT R.I.B.A. PUBLICATIONS

The following is a list of the main R.I.B.A. publications with their prices.

Agreement, Forms of

Form of Agreement for General Use between a Private Building Owner and an Architect or a Firm of Architects.

Form of Agreement for General Use between a Building Owner (being a Statutory Authority) and an Architect or a Firm of Architects.

Form of Agreement between a Local Authority and a Firm of Architects for Housing Work.

Form of Agreement between a Local Authority and a Firm of Architects for Multi-Storey Flats.

Form of Agreement between the Promoters and a Firm of Architects appointed as the Result of a Competition.

Price 6*d.* per form (inclusive of purchase tax). Postage 3*d.*

Architect and His Work, The
Price 6*d.* Postage 3*d.*

Before You Build. Free.

Certificates, Architects', Form Prepared by the Practice Committee
Copyright Book of 100 Certificates.
Price 17*s.* (inclusive of purchase tax). Postage 1*s.* 3*d.*

Conditions of Engagement and Scale of Professional Charges

Price 6*d.* Postage 3*d.*

Contract, Form of Agreement and Schedule of Conditions
For use with quantities: 1939 revised 1952. Copyright.
For use without quantities: 1939 revised 1952. Copyright.
Price 2*s.* 2*d.* per form (inclusive of purchase tax). Postage 3*d.*
Adapted for the use of Local Authorities, for use with quantities: 1939 revised 1952. Copyright.
Adapted for the use of Local Authorities, for use without quantities: 1939 revised 1952. Copyright.
Price 2*s.* 4½*d.* per form (inclusive of purchase tax). Postage 3*d.*
Fixed Fee Form of Prime Cost Contract for use in the repair of war-damaged property, 1946 revised 1954. Copyright.
Price 2*s.* 2*d.* (inclusive of purchase tax). Postage 3*d.*
Cost Plus Percentage Form of Prime Cost Contract for use in the repair of war-damaged property: 1946 revised 1954. Copyright.
Price 2*s.* 2*d.* (inclusive of purchase tax). Postage 3*d.*

Examination, Intermediate, Questions Set At
Price 1*s.* per examination. Postage 3*d.*

Examination, Professional Practice, Questions Set At
Price 6*d.* Postage 3*d.*

Examinations, Final and Special Final, Questions Set At
Price 1*s.* per examination. Postage 3*d.*

Forms of Articles of Pupilage
Copyright. Price 1*s.* 8*d.* (inclusive of purchase tax). Postage 3*d.*

Membership of the R.I.B.A.
Particulars of the Qualifications for Associateship.
Price 2*s.* 6*d.* Postage 3*d.*

Party Wall Notice Forms, for Use Under the London Building Act
Form A—Party Structures.
Form B—Party Fence Walls.
Form C—Intention to Build within Ten Feet and at a lower level than the bottom of the foundations of adjoining Owner's Building.
Form D—Intention to build within Twenty Feet of the adjoining Owner's Independent Building and to a depth as defined in Section 50 (1)(b).
Form E—Party Walls and Party Fence Walls on line of Junction of adjoining lands.
Form F—Walls or Fence Walls on Building Owner's land with footings and foundations projecting into adjoining Owner's land.
Form G—Selection of Third Surveyor.
Price 7*d.* per form (inclusive of purchase tax). Postage 3*d.*

New Building Materials and Preparations. The attention of members is drawn to the fact that information in the records of the Building Research Station, Garston, Watford, Herts, is freely available to any member of the architectural profession, and architects would be well advised, when considering the use of new materials and preparations of which they have had no previous experience, to apply to the Director for any information he can impart regarding their properties and application.

COMPETITION RESULT

Church and Church House at Liverpool—

1. D. G. MacConville [*A*].
2. S. W. Milburn and Partners [*FF/AA*].
3. Geoffrey P. Dawson [*A*].

ALLIED SOCIETIES

Changes of Officers and Addresses

Southport Architectural Society. President E. H. Honeyburne [*A*].

West Yorkshire Society of Architects, Harrogate Branch. Chairman, Eric Brown [*F*], 3 Victoria Avenue, Harrogate. Hon. Secretary, John Leigh [*A*], Flat B, 59 St. George's Road, Harrogate.

Dundee Institute of Architects. President, T. H. Thoms [*F*].

North Wales Architectural Society. President, Lieut.-Colonel Douglas Hall [*F*].

Alberta Association of Architects. President, K. C. Stanley, of Messrs. Dewar, Stevenson & Stanley of Edmonton, Canada. Hon. Secretary,

H. L. Bouey, 310 Northern Hardware Building, Edmonton.

Architects' Association of New Brunswick. President, Neil M. Stewart [*A*].

Institute of Southern Rhodesian Architects. President, C. Ross MacKenzie [*A*].

Manchester Society of Architects. Annual Dinner. The annual dinner of the Manchester Society of Architects was held at the Masonic Temple, Manchester, on Wednesday 30 March. Mr. G. B. Howcroft, M.C. [*F*], President of the Society, was in the Chair, and among the guests were Mr. C. H. Aslin, C.B.E., President R.I.B.A., and Mrs. Aslin; Mr. C. D. Spragg, C.B.E., Secretary R.I.B.A.; the Ven. A. Selwyn Bean, M.B.E., Archdeacon of Manchester; and Alderman Abraham Moss, J.P.

Mr. Howcroft proposed the toast of the R.I.B.A. and Mr. Aslin responded. Mr. F. Leslie Halliday, A.M.T.P.I. [*F*], proposed the toast of the City of Manchester and Alderman Moss replied. The toast of 'The Guests' was proposed by Mr. Cecil Stewart, A.M.T.P.I. [*F*] and the Archdeacon responded.

Norfolk and Norwich Association of Architects. Annual Dinner. The annual dinner of the Norfolk and Norwich Association of Architects was held at the Royal Hotel, Norwich, on Friday 18 March. It was a 'men only' occasion. Mr. Robert O. Bond [*F*], President of the Association, was in the chair, and among the guests were Mr. C. H. Aslin, C.B.E., President R.I.B.A., and Mr. C. D. Spragg, C.B.E., Secretary R.I.B.A.; Lord Hastings, J.P., D.L., Vice-Lieutenant of Norfolk; the Sheriff of Norwich, Mr. O. M. Tusting, J.P.; the Lord Bishop of Norwich, K.C.V.O., D.D.; and Brigadier Rawdon Briggs, C.B.E., D.S.O., M.C.

Lord Hastings proposed the toast of the R.I.B.A. and coupled with it a tribute to Mr. Aslin. He made a plea that identical plans should not be used for Council houses irrespective of the site and the direction in which the houses faced, since houses built facing north in Norfolk were unliveable-in. He mentioned the proposal to inspect churches every five years and the new field this opened up for young architects and said there was nothing more worth preserving in England than the parish church.

Mr. Aslin, replying, said that while ancient buildings were our heritage and heirloom, new buildings must represent the time, the people and the craftsmen of today.

The Sheriff proposed the toast of 'The Norfolk and Norwich Association of Architects' and Mr. Bond replied. Mr. Bond said that whereas the architect was once regarded purely as an artist, today he had to be a good business man and organiser on behalf of his clients. Mr. J. Gordon Davies [*F*] proposed 'The Guests', and the Bishop of Norwich and Brigadier Rawdon Briggs responded.

Northamptonshire, Bedfordshire and Huntingdonshire Association of Architects. Annual Dinner and Dance. The annual dinner and dance of the Northamptonshire, Bedfordshire and Huntingdonshire Association of Architects was held at the Solarium Restaurant, Overstone, Northampton, on Friday 11 March. Mr. H. D. Williams [*A*], President of the Association, was in the chair and he and Mr. Basil Spence, O.B.E., Vice-President R.I.B.A., welcomed some 170 members and guests. Among those present were Earl Spencer, Lord Lieutenant of Northamptonshire; the Mayor and Mayoress of Northampton and the Mayor and Mayoress of Kettering; Mr. J. L. Womersley, A.M.T.P.I. [*A*], now city architect of Sheffield but formerly borough architect to Northampton; and Mr. David Booth [*F*], President of the Berks, Bucks and Oxon Architectural Association. During the course of the evening Mr. Spence presented the R.I.B.A. Bronze Medal and diploma for the area to Mr. Womersley for the King's Heath Shopping Centre and a replica of the model and a plaque for fixing to the building to the Chairman of the Northampton Housing Committee.

Earl Spencer proposed the toast of the R.I.B.A. and its Allied Societies. While acknowledging the skill and taste needed by architects he deplored the tendency, he said, to make the exteriors of all buildings look alike. The interior of Coventry Cathedral, he said, would be one of the wonders of the twentieth century.

Mr. Spence, replying, said that a great common idiom had run through all the great periods of architecture. Tradition was vital but if we copied what has been done before we were not being traditional. It was the way of thinking of the great cathedral builders of the past, not their styles, that should be copied.

Mr. Williams proposed the toast of the guests, and the Mayor of Northampton responded.

Northern Architectural Association, Cumberland Branch. The annual dinner-dance was held in the Silver Grill, Carlisle, on 3 March 1955. The guests of honour were the Mayor and Mayoress of Carlisle, Alderman T. D. Lancaster, J.P., and Mrs. Lancaster; Alderman W. Dobinson, O.B.E., J.P., and Mrs. Dobinson; and the Chairman of the Carlisle and District Federation of Master Builders, Mr. A. S. Nixon and Mrs. Nixon. Among the 190 members and guests present were local representatives of associations connected with the building industry and the allied professions. Before the dinner the guests were received by the Chairman, Mr. R. A. Stewart [*A*] and Mrs. Stewart.

Sheffield, South Yorkshire and District Society of Architects and Surveyors. Annual Dinner and Dance. The annual dinner and dance of the Sheffield, South Yorkshire and District Society of Architects and Surveyors was held on Thursday 24 February at the Royal Victoria Hotel, Sheffield. Mr. H. A. Hickson [*F*], President of the Society, was in the chair and among the 280 members and guests who attended were Mr. F. C. Saxon, O.B.E., M.C., Vice-President R.I.B.A. and Chairman Allied Societies Conference; the Lord Mayor of Sheffield; the Mistress Cutler, Mrs. W. G. Ibberson; the Rev. G. S. Whitby, M.A., B.D., Minister of Upper Chapel, Sheffield; and the Presidents of the Nottingham, Derby and Lincoln Society of Architects, the York and East Yorkshire Society of Architects and the Manchester Society of Architects. Mr. C. H. Aslin, C.B.E., President R.I.B.A., and Mrs. Aslin were unfortunately prevented by illness from attending.

The Lord Mayor proposed the toast of the R.I.B.A. He referred to the 132nd Psalm—'Jerusalem is built as a city and at unity with itself' and regretted that he thought this could not be said of our modern cities with their 'concrete boxes built round a framework of steel erected on their ends'. He relied on the younger generation of architects, with their excellent architectural educational facilities, to build the new Jerusalem. Mr. Saxon, replying to the toast, said he agreed with the Lord Mayor in his criticism of the soap-box era which was now, he hoped, over. We were struggling to find what would best suit the purpose of modern building today. He pointed out that the R.I.B.A. was not run entirely from London but existed for the benefit of the whole architectural profession and London listened, he said, to what the provinces had to say.

Mr. J. L. Womersley, A.M.T.P.I. [*A*], City Architect of Sheffield, proposed the toast of 'Our Guests' and the Rev. G. S. Whitby, M.A., B.D., Minister of Upper Chapel, Sheffield, replied. He said he thought the public were not sufficiently aware of the architect's vital place in society, and as a result the architect sometimes lacked adequate opportunity; he hoped nevertheless that Sheffield would one day be as famous for its architecture as it was today for its steel and its lovely surroundings.

South Wales Institute of Architects. Annual Dinner and Dance. The annual dinner and dance of the South Wales Institute of Architects was held at the Park Hotel, Cardiff, on 11 February. As is now an established custom, the Welsh School of Architecture students joined with the Institute in the dance. The President of the South Wales Institute, Mr. L. R. Gower [*F*], was in the chair, and among the guests were Mr. C. H. Aslin, C.B.E., President R.I.B.A., and Mrs. Aslin; Mr. David Prosser, F.J.I., President of the Guild of British Newspaper Editors; the Deputy Lady Mayoress of Cardiff; and Mr. Raymond Gower, M.P.

Mr. Prosser proposed the combined toast of the R.I.B.A., the South Wales Institute of Architects and the Welsh School of Architecture. Mr. Aslin and Mr. Gower responded. Mr. W. Stephen Thomas [*A*], Vice-President of the South Wales Institute, proposed the toast of the guests and the Deputy Lady Mayoress and Mr. Raymond Gower replied.

GENERAL NOTES

Marley Tile Travelling Scholarship for the Study of Architecture in Mexico, Venezuela and Brazil. The response to the announcement of this scholarship, value £750 (announced in the January issue of the JOURNAL), totalled some 72 applications from all parts of the world. The assessors were unanimous in awarding the scholarship to Mr. Gordon Graham, Dip. Arch. [*A*].

Mr. Graham is 34 years of age. He is in private practice and is a lecturer at the School of Architecture, College of Arts and Crafts, Nottingham. He was Arthur Cates prizewinner 1953 and also winner of the essay prize offered by the Anglo-Brazilian Society in 1954.

The assessors were: Mr. Howard V. Lobb, C.B.E. [*F*], Mr. H. T. Cadbury-Brown [*F*] and Mr. Richard Aisher of the Marley Tile Co. Ltd.

Membership Lists

ELECTION: 5 APRIL 1955

The following candidates for membership were elected on 5 April 1955.

AS FELLOWS (10)

Adamson: Hamish Edgar Donald [*A* 1946].
Davidson: John William [*A* 1946], Sheffield.
Gray: Andrew Leslie [*A* 1934].
Maitland: James [*A* 1931].
Oliver: Douglas John, Dip.Arch. (The Polytechnic) [*A* 1942], Rugby.
Pite: Frederick Robert [*A* 1947], Sevenoaks.
Ratcliff: John Clifford, O.B.E., A.A.Dipl., A.M.T.P.I. [*A* 1938].

and the following Licentiates who have passed the qualifying examination:

Barraud: Ronald, Nottingham.
Grant: Robertson Reid.

and the following Licentiate who is qualified

under Section IV, Clause 4(*c*)(ii) of the Supplemental Charter of 1925:

Goodman: Stanley Vincent, Bedford.

AS ASSOCIATES (144)

Armstone: David Henry, Barrow in Furness.
Ashley: Raymond, Nottingham.
Atkins: Brian Thomas Edwin, B.Arch.(L'pool), Leamington Spa.
Bailey: (Mrs.) Janet Katharine, Dip.Arch. (Sheffield), Sheffield.
Bates: Lawrence William, Dip.Arch.(Sheffield), Sheffield.
Beech: William Jack, Auckland, New Zealand.
Bell: Alexander Duncan, D.A.(Dundee), Blairgowrie.
Bell: Allan Fraser, D.A.(Dundee), Broughty Ferry.
Bell: Sydney Ernest, Dip.Arch.(Birm.), Coventry.
Bestwick: Terence Hugh, Dip.Arch.(Nottm.), Shipley.
Brackston: John Henry, Dip.Arch.(Birm.), Droitwich.
Brayshaw: Alan Michael, B.A.(Sheffield), Chesterfield.
Bridgeman: Charles Robert, Dip.Arch.(Birm.), Lichfield.
Broadbent: Geoffrey Haigh, B.A.(Arch.) (Manchester), Huddersfield.
Brown: Sidney Frederick Charles, Dip.Arch. (Birm.), Solihull.
Bruce: Robert, Ramsey, Isle of Man.
Butcher: Thomas Richard, Dip.Arch. (C.T.), Vereeniging, Transvaal, S. Africa.
Carton: Donald Brian, B.A.(Arch.) (Manchester), Newcastle, Staffs.
Cartwright: Douglas, B.A.(Sheffield), Manchester.
Coleman: Thomas Henry de Witt, Birmingham.
Collins: Kenneth Vaughan, Dip.Arch.(Birm.), Birmingham.
Craigie: William Melrose, D.A.(Glas.), Glasgow.
Cree: David Norman Leslie, B.A.(Arch.) (Sheffield), Sevenoaks.
Crofts: Percy Francis, Dip.Arch.(Leics.), Leicester.
Curtis: Anthony Henry, B.Arch. (Auck., N.Z.), Auckland, New Zealand.
Davidson: David John McKenzie, West Cults.
Davies: Howell Haydn, Dip.Arch.(Birm.).
Dawes: Stanley B. (L), Dagenham.
Dixon: Maurice Raylton, Dip.Arch.(Birm.), Birmingham.
Downs: Donald Alexander Primrose, Dip.Arch. (The Polytechnic), Westerham.
Ellison: Charles D., B.Arch. (N.U.I., Dublin), Blackrock.
English: John Mayne, B.Arch. (C.T.), Lusaka, Northern Rhodesia.
Farmer: Edward James Fraser, D.A.(Dundee), Broughty Ferry.
Firman: Merlin John Lingard, Bristol.
Fitzhardinge: Richard Grantley.
Ford: John Pierpoint, Dip.Arch.(Dunelm), Southampton.
Foster: Alan Bertram, Dip.Arch.(Manchester).
Friendly: Ivor Russell, Cape Town, S. Africa.
Gibson: Arnold George Lowe, Dip.Arch.(Birm.), Northampton.
Goddard: John Springate, Dip.Arch.(Birm.), Birmingham.
Goer: Jeremy Arthur Thomas, Dip.Arch.(Birm.), Bloxwich.
Grabowski: Stanislaw, M.A.(Cantab.).
Graves: Roy Albert, Dip.Arch.(Sheffield), Oakington.
Green: Spencer Hewlett, Dip.Arch.(Manchester), Prestbury.
Greenwood: Frank, Dip.Arch.(Manchester), Luddenden Foot.
Greenwood: Peter Gordon, Dip.Arch.(Sheffield), Sowerby Bridge.
Gregson: John Kenneth, Dip.Arch.(Manchester), Wrexham.
Grimsley: Geoffrey Edward, Dip.Arch.(Manchester), Burton-on-Trent.
Harper: Henry John, Dip.Arch.(Birm.), Birmingham.
Harris: James Broughton, Dip.Arch.(Manchester), Bolton.
Harris: Stanley Walter McKendrick, D.A. (Glas.), Paisley.
Haslock: (Miss) Anne, D.A.(Dundee), Dundee.
Hawkins: Edwin George, Dip.Arch.(Birm.), Birmingham.
Hayes: Arthur Howard, Dip.Arch.(The Polytechnic).
Henderson: John, D.A.(Dundee), Anstruther.
Herniman: Edwin Richard, Dip.Arch.(Sheffield), Crewe.
Higginbottom: Arthur, Dip.Arch (Sheffield), Glossop.
Hill: Eric Percy, Bath.
Hill: Roger John, Dip.Arch.(Sheffield), Maidenhead.
Hoenig: Edwin, Dip.Arch.(The Polytechnic).
Houghton: Frederick Michael Gladstone, M.C.D., B.Arch.(L'pool), Birmingham.
Houseman: John Robert, B.A.Arch.(Manchester), Macclesfield.
Howard-Radley: Malcolm, Dip.Arch. (The Polytechnic).
Hudson: (Miss) Rosemary, B.Arch.(Dunelm), Sunderland.
Hunt: James Keith, B.A.(Arch.) (Manchester), Preston.
Hutchings: David Ronald Ernest, Dip.Arch. (Birm.), Barnt Green.
Ireland: Ronald, D.A.(Dundee), Dunoon.
Irwin: David Robert, Dip.Arch. (The Polytechnic).
Jepson: Brian, Dip.Arch.(Manchester), Chester.
Jones: Peter, Dip.Arch. (The Polytechnic), Upminster.
Jordan: Peter, B.A.(Arch.) (Manchester), Manchester.
Kay: Robert, Dip.Arch.(Manchester), Ashton-under-Lyne.
Knightley: Derrick Arthur, Dip.Arch.(Leics.), Leicester.
Leadley: John Ashby, Dip.Arch.(Birm.), Birmingham.
Lewis: David Godfrey, B.Arch.(Wales), Winchester.
Lewis: Derrick David John, A.A.Dipl.
Lines: John Anthony, B.A.(Manchester), Huddersfield.
Longshaw: Leslie Frederick.
Longville: Joseph Nixon, Dip.Arch.(Dunelm), Sunderland.
McClelland: Robert Brodie, Dip.Arch. (The Polytechnic), Addiscombe.
McIntosh: Ian David, D.A.(Dundee), Dundee.
McLeod: George Gunn, D.A.(Edin.), Perth.
Main: William Edwards, Dip.Arch.(Abdn.), Aberdeen.
Mar: William, B.Arch.(Sydney), Killara, N.S.W., Australia.
Mate: Henry Edward, Wakefield.
Matty: Leonard Charles, Dip.Arch.(Birm.), Smethwick.
Mehta: Harkant Manlal, Bombay, India.
Metcalf: Arthur Edward, B.Arch.(L'pool), Derby.
Miller: William, Dip.Arch.(Manchester), Manchester.
Miller-Forward: Anthony Charles, B.A.(Arch.) (Manchester), Coventry.
Milne: William Rollo, Dip.Arch.(Abdn.), Aberdeen.
Mitchener: Allan Leonard, Dip.Arch.(Auck., N.Z.).
Morgan: Peter William, Dip.Arch.(Birm.), Walsall.
Needham: Bernard, Dip.Arch.(Manchester), Manchester.
Neyman: Lech.
Nilsen: Johan Gordon, Dip.Arch.(Sheffield), Sheffield.
Noble: Ian Allan, Dip.Arch.(The Polytechnic).
O'Farrelly: Peter Edward, B.Arch.(N.U.I., Dublin), Dublin.
Opie: (Mrs.) Pamela Elizabeth, Newcastle upon Tyne.
Osborne: Anthony Robert, Dipl.Arch.(U.C.L.).
Owen: Richard, Southend-on-Sea.
Park: John Courtney, Dip.Arch.(Manchester), Windermere.
Paterson: Derek Paul, D.A.(Glas.), Stirling.
Patrick: Ian Roy, A.S.T.C.(Arch.), Sydney, N.S.W., Australia.
Paul: Ian William, Elgin.
Pert: William Watt, D.A.(Dundee), Montrose.
Phelps: Michael John, Dip.Arch.(Birm.), Shanklin, Isle of Wight.
Prime: Harold Edward John, Westcliff-on-Sea.
Pringle: Malcolm John, Dip.Arch.(Dunelm), Hertford.
Reid: Norman Hunter, D.A.(Edin.), Edinburgh.
Renville: Andrew Terras, Dip.Arch.(Leics.), Horley.
Roach: Peter Frederick, Dipl.Arch.(U.C.L.).
Robinson: John Keith, Dip.Arch.(Manchester), Widnes.
Robotham: Joseph, Dip.Arch.(Sheffield), Stoke-on-Trent.
Rose: Raymond Thomas, Hemel Hempstead.
Rowberry: Conrad Stuart, Dip.Arch.(Birm.), Coseley.
Russell: (Miss) Eleanor Galbraith, D.A.(Edin.), North Berwick.
Sargent: John Uley, B.A.(Arch.) (C.T.), Cape Town, S. Africa.
Scaife: John, Portsmouth.
Sethna: Dhunjibhoy Kawasji, Bombay, India.
Sethna: Faramarz Bejonji, Bombay, India.
Sharp: Michael Hammond, Dip.Arch.(Manchester), Stockport.
Silk: Thomas Eugene, A.S.T.C.(Arch.), Cammeray, N.S.W., Australia.
Simms: Charles Philip, Dip.Arch.(Sheffield), Newcastle, Staffs.
Stewart: Anderson, D.A.(Glas.), Belfast.
Sutherland: Peter Berkeley Douglas, M.A. (Cantab.), Dipl.Arch.(U.C.L.), Maidenhead.
Swift: Raymond Trevor, Dip.Arch.(Sheffield), Doncaster.
Swithenbank: Michael Herbert, Dip.Arch. (Manchester), Bury.
Tempest: Peter Squire, Dip.Arch.(Sheffield), Bradford.
Thompson: Leslie Dennis, Dip.Arch.(Nottm.), Southampton.
Thornhill: Desmond, Dip.Arch.(Nottm.), Darley Dale.
Tovey: Robert Olwyn Barrington, Dip.Arch. (Sheffield), Cheltenham Spa.
Troy: Peter Mitchel, Dip.Arch.(Birm.), Birmingham.
Walker: Ralph, D.F.C., Birmingham.
Wallis: Matthew, D.A. (Edin.), Coventry.
Wann: William Tollan, D.A.(Edin.), Kirkcaldy.
Ward: Anthony Fisher, Dip.Arch.(Sheffield), Sheffield.
Waterston: Edward Munro, Cheltenham.
Wells-West: Keith Harold.
Whittaker: Neville, B.Arch.(Dunelm), Barnsley.
Williams: Kenneth John, Dip.Arch. (The Polytechnic).
Worsley: Geoffrey Leonard, B.A.(Arch.) (Manchester), Manchester.
Wright: Edmund Morton, Dip.Arch. (The Polytechnic), Beckenham.
Wylson: Anthony John, A.A.Dipl., Salisbury, S. Rhodesia.

AS LICENTIATES (2)

Abercromby: Alexander Webb, Alloa.
Luke: Arthur, Huntingdon.

Obituaries

Sir Harry Vanderpant [*Hon. A*] died on 20 March, aged 89.

Sir Ian MacAlister writes:

'By the death of Harry Vanderpant the R.I.B.A. has lost the oldest and probably the best friend that it ever had. Sixty-five years ago he became Secretary to Henry L. Florence, who won the Soane Medallion in 1869 and became one of the most prominent and successful architects of his time. He served on the Council of the R.I.B.A. for many years and filled the office of Vice-President. When he died Vanderpant made it one of the chief objects of his life to honour and perpetuate the memory of his late chief and friend. When the new building was under construction he gave to the R.I.B.A. the sum of £10,000 to be employed in two ways. The first was the endowment of a beautiful hall to be named the Henry L. Florence Hall, the second was the creation of the Henry L. Florence Bursary for the encouragement of the study of architecture in and around the Eastern Mediterranean. The names of the holders of the Bursary since 1933 are a proof of the value of Vanderpant's conception and the reports of the Bursars are monuments of scholarship. Now by his will he has given a further £10,000 to the R.I.B.A. which may be used to increase the value of the Bursary. He was always intensely interested in the R.I.B.A., its daily work and its home, but he never seemed concerned with his prominence in connection with it. He was simply glad and proud to be in a position to commemorate the name and work of Florence. He was one of the most generous friends of the A.B.S. and served on its Council for many years. His final gift to it is a legacy of £1,000.

'Vanderpant was a remarkably many-sided man. Called to the Bar nearly 40 years ago, he was for many years a member of the Westminster City Council and he was Mayor of Westminster in 1937. He was a Deputy-Lieutenant of the County of London and for eleven years held the important position of Chairman of the London and Home Counties Traffic Advisory Committee. A handsome man of fine presence and genial manners, he will be sincerely missed by the large number of real friends who knew and valued his sterling character.'

John Christopher Casey [*L*] died on 1 February aged only 46. After graduating in Mr. Cowles-Voysey's office and then with Mr. P. J. Westwood he joined the firm of Searle & Searle in June 1933 as an assistant. In 1941 he was taken into partnership. Mr. Norman Searle [*A*] writes:—

'Mr. Casey was an Irishman of a most lovable character and wherever his busy practice took him he was universally popular, whether contacts were with client, contractor or Ministry. His efficiency and knowledge of building were exemplary and his high sense of honour and humour made him a valued companion in all his official and private undertakings. His surviving partners mourn his passing.

'He would readily suffer interruptions in the middle of some difficult commission and cheerfully give the right answer. When charged with a difficult telephone approach to some Ministry it was pretty obvious that after the opening skirmish followed by a few well-chosen remarks he had already won the official's sympathy, and in the end the case he put forward was usually accepted. His draughtsmanship was of a very high order and a delight to his partners. In his early days with us, when he worked on a number of Sussex houses, hospitals, churches, schools and other drawings, his notes of construction in minute printing were so prolific that very little scope remained for the specification writer.

'In 1948 he took part with distinction in the designs for the new premises for Hitchcock Williams in St. Paul's Churchyard, and also in those for large blocks of flats and the additions to Forest School and other new designs. He was a member of the Catenian Association and a past Chairman.

'In the summer of 1954 his health suddenly failed, but after four months' hospital treatment he returned to work and even regained his old humour. On the evening of 31 January he said goodnight to all his partners at Amen House and after making his usual business appointments for the morrow he went home. We subsequently were shocked to hear that early next morning he entered his former hospital of St. John and St. Elizabeth and after rearranging his day's appointments was persuaded by his friends at the hospital to rest awhile. Soon after, he passed away.'

John Fraser Matthew [*F*] died on 31 January, aged 80.

Mr. Matthew was articled to Sir Robert (then Mr.) Lorimer and attended the School of Applied Arts, the Heriot Watt College and the University of Edinburgh. His articles completed, he remained as assistant and later became a partner.

His principal works, carried out during the partnership and after Sir Robert's death, include a new department for engineering, geology, zoology and animal genetics at Edinburgh University; the Students' Union at King's Buildings; the Earl Haig Homes, Saughton, Edinburgh; Edinburgh Crematorium; various memorials, including those at Rossall, Stowe and Loretto Schools; an extension to the Royal Dick Veterinary College, Edinburgh; a memorial hall at St. Mary's Cathedral, Edinburgh; various wood carving and heraldry work at St. Giles' Cathedral, and Thistle Chapel, Edinburgh; Granton Church of Scotland, Edinburgh; St. Margaret's Church, Knightswood, Glasgow; the Thistle Foundation Chapel, Craigmillar, Edinburgh; and various wrought iron work and church furniture.

Mr. C. d'O. Pilkington Jackson, sculptor and member of the Royal Fine Art Commission for Scotland, sends the following account of Mr. Matthew's career:

'While calling at an Edinburgh house in 1893 Miss Lorimer was so impressed by a model of Holyrood Palace that she borrowed it to show to her brother Robert, who had lately set up in practice as an architect. Within 24 hours young John Matthew, aged 17, who made the model, had been interviewed and engaged as an apprentice. So began a life-long association which ended in partnership. Lorimer said later that he had instantly sensed in Matthew's drawings and personality an affinity with his own taste and outlook; events proved him to be right.

'John Matthew was notable for his ability to collaborate, to assimilate and to develop his employer's ideas. He had a great capacity for work and enjoyment of a full life. A keen volunteer and crack rifle shot, he served with the Royal Scots in the South African War as a sergeant and during this period wrote home a remarkable and voluminous series of descriptive and illustrated letters of his experiences, which still exist.

'By 1908 he had given up all outside interests to devote himself to the management by day of Lorimer's practice, now of international reputation. By night he designed and drew indefatigably. This meant much sacrifice of family life, but he received every support from his devoted wife. The 1914–18 war saw him again on active service, this time with the Royal Corps of Signals, in which he became a Major. He was twice mentioned in despatches.

'He was taken into partnership in 1927 and, upon the now Sir Robert Lorimer's death, carried on the practice as sole partner. He lived to see his sons Robert and Stuart attain distinction in the profession.

'Previous to partnership he had more than one tempting offer both at home and abroad, but evidently preferred to remain working under conditions which he felt to be congenial. Like Lorimer, he had great love for and always used the visual arts and their craftsmen at every opportunity. His own drawings were sensitive and precise, qualities which he fostered in his assistants; few sheets left the office without characteristic touches by his own hands.

'The many note-books of measured sketches which he filled are a pleasure and an education to browse over. In addition he left a day-by-day record of his life and work written in a beautiful hand that seemed never to hesitate. There can be little doubt that had he been less modest and self-effacing he would have "gone further" in a worldly sense, but these very qualities coupled with his creative ability, made working with him or under him a privilege.'

Mr. Harry Hubbard [*A*] adds the following:

'The 20 years and more which have passed since the writer was an assistant with Lorimer & Matthew have blurred the outlines of day-to-day experience but have not been able to dim the memory of a friendly and likeable personality.

'John F. Matthew was a man who combined a love of a joke with a keen sense of the ridiculous, and perhaps this "pawkiness" tended to conceal from some the brilliance of the real man. He was a fine draughtsman but we had regrettably few opportunities of appreciating this because he devoted so much of his time to running the business side of the practice—a task which he tackled with outstanding ability and a real flair for organisation. "J. F." worked hard—just how hard we in the office, enjoying his pleasant easy-going company, hardly realised; but many a sketch design went home with him and was worked out in the small hours.

'John Matthew was an optimist: one who faced life with a smile and encouraged others to do the same.'

Mr. Stuart R. Matthew [*A*] carries on the practice. Mr. J. F. Matthew's other son, Robert, is of course Professor Robert Matthew, C.B.E. [*A*], Professor of Architecture at Edinburgh University.

George Clifford Oldham [*L*] died on 4 June 1954, aged 65. He had been living in New Zealand since 1948.

Mr. F. Aylmer Howard [*A*], of Blandford Forum, Dorset, has sent us the following notice:

'George Oldham was educated at Gresham's School and on leaving entered the regular army, being commissioned to the Queen's Royal Regiment in 1918. He was an instructor on the army gymnastic staff and later joined the Royal Air Force as a pilot. After four years he had to retire owing to ill health.

'Architecture had always been of great interest to him and he spent one of his periods of leave working on designs for the DAILY MAIL "Ideal Home" competition. After his retirement he devoted all his time to architecture, and became a Licentiate in 1941. He developed a very definite style of his own and many small dwellings built to his designs have enriched the countryside in Dorset, where he lived until he left this country. He was appointed architect to

the Wareham Corporation for their post-war housing and also carried out several schemes for the Wimborne and Cranborne R.D.C.

'Indomitably cheerful and enthusiastic despite his ill health, he was eventually persuaded to leave England for a less arduous climate, and sailed for New Zealand in 1948. He became an Associate of the New Zealand Institute of Architects and had the beginnings of a most promising practice in Gisborne when in 1950 his health broke down completely. After years of illness borne with immense fortitude and even gaiety, he died on 4 June 1954.'

Arthur Welford, F.S.A. [*F*], former Member of Council and of the Art Standing and Registration Committees, died on 22 January, aged 70. Mr. R. S. Balgarnie Wyld [*A*] writes:

'Arthur Welford, after completing his pupilage with E. J. May, remained on as an assistant in the same office. He at a later date acted as assistant clerk of works under Pite on the then new large King's College Hospital building at Denmark Hill. He began practice in Hart Street, Bloomsbury, in 1909. When the First World War started he was one of the first to volunteer, and after being commissioned in the R.A.S.C., he was transferred to the R.E., finishing the war on the Salonika Front. On demobilisation he recommenced practice in Gray's Inn Place.

'His work was chiefly domestic, with some factory and shop work. For some years he was engaged on the design and layout of a large building estate at Willesden. These houses were an example of good taste in a field which at that time was ruled by the speculative builder. At this time he became a member of the Art Workers' Guild and served on the Council of the R.I.B.A.

'A third move was made, this time to Peasenhall in Suffolk. This Suffolk and later period of his life opened up a large number of new interests. Besides his domestic work he was increasingly consulted by authorities requiring advice on old building preservation; he acted for the Central Committee for the care of Churches, and was a member of the St. Edmundsbury and Ipswich Advisory Committee for the Care of Churches. He was a life member of the Suffolk Institute of Archaeology, and was elected a member of the Blyth R.D.C., and, later on, the Deben R.D.C.

'Often against strong opposition he was enabled to get qualified architects employed on work which had previously been done without any such control. In 1939 he was instrumental in saving some condemned 16th-century cottages and restoring them accurately and completely. He was elected a Fellow of the Society of Antiquaries. He was for some time chairman of the Commissioners of Income Tax and chairman of the East Area Joint Planning Committee.

'He was a keen east coast yachtsman and a lover of the countryside. He had exceptional ability as a draughtsman, water colourist and etcher, with a particularly delicate touch to his pencil drawings. Some of his perspectives were exhibited at the Royal Academy. To me he was a friend for over 50 years, whose death leaves happy memories of long architectural discussions and many sailing trips together. He was above all a man of great artistic integrity, he never trimmed his sails.'

Francis Andrew Oldacre Jaffray [*F*], of Salisbury, Southern Rhodesia, died on 1 September 1954, aged 74.

Mr. Jaffray trained in England, then went to South Africa in 1908. From 1920 onwards he had practised in Salisbury, Southern Rhodesia, and his principal works are the State Lottery Hall; Africa House and New Africa House; Beit Hall, St. George's College, Salisbury; a chapel for St. John's School, Avondale; Nazareth House, Salisbury; and the Umtali Convent School.

Mr. E. B. Rowland [*A*], with whom Mr. Jaffray entered into partnership in 1950, carries on the practice.

Mr. Jaffray was one of the early members of the Institute of Southern Rhodesian Architects. He was the author of a number of articles on architectural subjects for the Press and of a book commemorating the anniversary of the arrival of the Pioneer Column at Fort Salisbury.

John Burland Chubb [*Retd. F*] died on 23 January, aged 94. He had recently completed 50 years as a Fellow of the Institute.

Mr. Chubb spent his childhood at Greenwich and was educated at Merchant Taylors' School, then in the City of London. He was always a devout churchman and while serving his articles he and some young men friends shared a house in which they lived almost as a religious community. It was called the Community House, and although Mr. Chubb left it on his marriage in 1895 it continued in existence until the First World War.

Soon after Mr. Chubb qualified he was appointed architect and surveyor to the Foundling Hospital in Bloomsbury—now the Thomas Coram School at Berkhamsted. Here he had charge not only of the building itself but also of the extensive property belonging to it in the London squares adjacent to it. After his retirement Mr. Chubb went to live at Froyle, near Alton, Hampshire, where his life continued to centre around his local church, and where he served on the local council until 1941; during which time he took an active interest in the council's planning work.

Henry Richard Creighton [*Retd. L*] died on 22 January, aged 78.

Mr. Creighton was in the Architect's Department of the London County Council. Before the war he was largely engaged in work on slum clearance and on the design of air raid shelters. He resigned in 1940 owing to ill health.

Sydney Charles Jury [*Retd. F*] died on 1 January 1955, aged 69.

Mr. Jury was articled to his father, Mr. Frederick C. Jury, in St. Austell, Cornwall, and went into partnership with him in 1906. He later became architect to Bedfordshire County Council and was a founder member of the County Architects' Society. Works carried out during his period of office include extensions to the Shire Hall, Bedford, Luton High School for Girls, the maternity block and nurses' wing to Bedford General Hospital and numerous police stations, police houses and schools.

Edward Prentice Mawson [*F*] died on 22 December 1954, aged 69.

Mr. Mawson studied at the Architectural Association School and at the Ecole des Beaux Arts, Paris. In 1910 he began practice in partnership with his father, Thomas H. Mawson, and his brother, J. W. Mawson. At the time of his death he was in partnership with Mr. Gordon H. Farrow and Mr. Thomas P. Mawson, who now carry on the partnership.

Mr. Mawson's name is associated with the gardens of the Palace of Peace at the Hague, with town planning schemes for Athens and Salonika, with Stanley Park, Blackpool, 'The Wood', South Tawton, Devonshire, with the pavilion at Weston-super-Mare and with Droitwich Spa baths. He had a specialist knowledge of river pollution, afforestation and structural damage due to trees. He collaborated with his father in writing *The Art and Craft of Garden Making*. He was also the author of the Fylde Regional Report. He was awarded the R.I.B.A. Distinction in Town Planning in 1945.

Frederick McIntosh Glennie [*F*] died on 26 April 1954, aged 65.

Mr. Glennie practised in Cape Town, after training under Sir Herbert Baker.

He was best known there for his commercial buildings, among the better known ones being the Exchange Building, the Alliance Assurance and the London Assurance. He also designed the Sea Point Lido, the Bay View Hotel at Hermanus, and the Cape Town Training College.

Mr. Glennie was a prominent Catholic and was responsible for the renovation of St. Mary's Cathedral. He designed the Pius XII Catholic University College at Roma, Basutoland, also many churches and convents throughout the Cape. He was an authority on old Cape Dutch architecture, and was responsible for restoring the Tulbagh Museum and the Old Supreme Court in Cape Town. His drawings of old Cape Dutch architecture were reproduced in Dorothea Fairbridge's *Historic Houses of South Africa*, and G. E. Pearse's *Eighteenth Century Architecture in South Africa*.

William Arthur Lewis [*A*], of Lewis & Hickey, Regent Street, London, died on 17 March, aged 85.

Mr. Lewis was a student at the Architectural Association School and began private practice in 1896. In 1930 he joined in partnership with Mr. P. Hickey [*F*] and Mr. G. N. Lewis [*A*]. He designed a number of office blocks, head offices for the Singer Sewing Machine Co. Ltd., the Maypole Dairy Company, Marks and Spencer and Tootal Broadhurst Ltd., also several hotels and blocks of flats.

Mr. Lewis was a past Master of the Plumbers Company, and in that capacity contributed in no small measure to furthering research in matters relating to plumbing and kindred trades. It is believed that he initiated the proposal to establish a qualifying examination for plumbers.

Edward Loveluck, F.R.I.C.S. [*A*] died after a long illness on 21 March. He practised at Bridgend, Glamorgan, where he was well known and of which he was a native. He had an extensive practice, comprising private houses, local authority housing, business premises and other kinds of building. He had also been responsible for planning schemes and was consultant to the old mid-Glamorgan Joint Planning Committee before their duties were taken over by the County Council.

Mr. Loveluck was well versed in the local lore, history and archaeology of the Vale of Glamorgan. A J.P. of many years' standing, he was for some time Chairman of the Juvenile Court, Ogmore and Newcastle Division, at Bridgend and Maesteg. In his younger days he was a member of the Bridgend U.D.C. and took a keen interest in local affairs.

Mr. T. Alwyn Lloyd, LL.D., F.S.A. [*F*], who furnished the above information, concludes: 'Those who knew or worked with Edward Loveluck had the greatest respect for his technical ability, breadth of knowledge and good fellowship.'

Members' Column

This column is reserved for notices of changes of address, partnership and partnerships vacant or wanted, practices for sale or wanted, office accommodation, and personal notices other than of posts wanted as salaried assistants for which the Institute's Employment Register is maintained.

APPOINTMENTS

Mr. David Cathels [*A*] has taken up an appointment as Architect and Town Planning Assistant with the Municipality of Penang, Malaya. His address is now c/o Town Planning and Building Department, Municipal Offices, Penang, Malaya.

Mr. A. G. Christopherson [*A*] has resigned his appointment with the Middlesex County Council and has taken an appointment with the New Zealand Ministry of Works in Auckland.

Mr. Anthony S. Hunt [*A*] has been appointed Government Architect to the Government of Qatar, Doha, Persian Gulf, and he will be pleased to receive trade catalogues, etc.

Mr. C. R. Kirby [*A*] has taken up an appointment as Resident Architect to the Dowty Group Ltd., Arle Court, Cheltenham, and will be pleased to receive trade catalogues, etc.

Mr. George G. Pace, F.S.A. [*F*] has been appointed Consultant Architect for Durham Cathedral in succession to the late Sir Charles Peers.

Mr. Desmond Ivor White [*A*] has been appointed architect to the Taranaki Education Board. His address will be Education Office, New Plymouth, New Zealand.

PRACTICES AND PARTNERSHIPS

Mr. Patrick J. Cullingworth [*A*] has entered into partnership with Mr. George H. Kerr [*A*]. The firm will practise under the style of **Kerr and Cullingworth** at 108 Ross Block, Saskatoon, Saskatchewan, Canada and will be pleased to receive catalogues of building products available in Canada.

Messrs. Fairbrother, Hall and Hedges [*LL*] have taken into partnership **Mr. Noel A. Cowburn** [*A*]. The name of the firm will continue as before.

Mr. Sydney Litherland, A.M.T.P.I. [*A*] has formed an association with **Mr. Deryck Bellamy** [*A*]. They will practise as architects, town planning consultants and landscape architects at P.O. Box 1890, 26 Jameson Avenue, Salisbury, S. Rhodesia, where they will be pleased to receive trade catalogues and samples.

Mr. Alex S. MacKenzie [*A*] has resigned his appointment with Dunbarton County Council and has begun practice at 84 Eton Place, Dumbarton Road, Duntocher, near Clydebank, Scotland, where he will be pleased to receive trade catalogues, etc.

Mr. C. A. Wells Neil [*A*] has begun practice at 5 Bystock Terrace (Clock Tower), Exeter, where he will be pleased to receive trade catalogues, etc.

Messrs. Trehearne and Norman, Preston and Partners have taken into partnership **Mr. P. R. Preston** [*A*] and **Mr. G. Gneditch,** M.B.E. [*A*]. They will continue to practise under the same name at 83 Kingsway, London, W.C.2.

The section of the practice in India of **Messrs. W. W. Wood, Sons and Partners** [*F*] which has been carried on in Calcutta by Mr. C. J. Parker [*F*] and Mr. J. D. Batra at No. 17 Stephen House, Dalhousie Square, Calcutta, has been taken over by Messrs. Episcopo and Bajpai. **Mr. C. J. Parker** [*F*], Mr. J. D. Batra and **Mr. I. H. Holman** [*A*], will continue their out-of-India practice at Crosby House, Robinson Road, Singapore, Malaya, as from 1 May next, under the name of Messrs. W. W. Wood, Sons and Partners.

CHANGES OF ADDRESS

Mr. C. W. Coster [*A*] has changed his address to Sarum Cottage, Gatton Road, Reigate, Surrey.

Messrs. Davies and Arnold [*F*] have now moved to 44 Lowndes Street, London, S.W.1 (BELgravia 3396).

Messrs. Dinerman, Davison and Partners [*A A*] have removed their offices to 15 Perrin's Lane, Hampstead, N.W.3 (SWIss Cottage 2949).

The School of Architecture, Dundee College of Art, has removed to its new building, the address now being Belmont, Perth Road, Dundee. The Head of the School will be pleased to receive trade catalogues and samples of building materials at the new address for inclusion in the Building Materials Library.

Messrs. J. Gibson Cowe and Son [*L*] have removed from their Chester-le-Street offices to Claremont Chambers, 1 Claremont Place, Newcastle upon Tyne (Newcastle 24319), also at 6 Tynemouth Terrace, Tynemouth (North Shields 1176).

The telephone number of **Mr. W. H. Gill** [*A*] is now FREmantle 4649.

Mr. H. M. Hughes [*A*] has changed his address to 180 Rodway Road, Tilehurst, Reading, Berks.

Mr. F. H. Kerr [*F*] has moved from 3 Malew Street to Balcony House, The Square, Castletown, I.O.M. (Castletown 3101) where he will be pleased to receive trade catalogues.

Mr. J. L. H. Kitchin [*A*] has changed his private address to 2 Holland Villas Road, Kensington, W.14.

Mr. C. A. L. Levick [*A*] has changed his address to c/o P.O. Box 651, Nairobi, Kenya.

Mr. G. S. K. Locke [*A*] has changed his address to 72 Glenela Street, Mount Pleasant, Western Australia.

Mr. E. W. Marshall [*A*] has changed his address to 49 Harrowby Street, London, W.1 (AMB. 9350).

Mr. C. Piazza [*L*] has changed his address to 8 Cromwell Place, S.W.7, and will continue to practise under the title of Watkin and Piazza.

Mr. John Powell [*A*] has moved to 158 Brooklands Avenue, Seacroft, Leeds 14.

Mr. Ian B. Simpson [*F*] is now at 611 Courtney Street, Victoria, British Columbia.

Mr. L. B. Smith [*A*] has changed his office address to 13 Beauchamp Place, Knightsbridge, London, S.W.3 (KNIghtsbridge 5138).

PRACTICES AND PARTNERSHIPS WANTED AND AVAILABLE

Licentiate (40), at present Chief Assistant, seeks partnership in London, Home Counties, or South Coast areas. Wide experience including industrial and commercial work. A small amount of capital available if required. Would consider purchase of suitable small practice. Box 16, c/o Secretary, R.I.B.A.

Member, Dip. T.P. (43), twenty years' good general experience, at present architect to large industrial concern, desires partnership in established practice or position leading to partnership. Capital available. North of England preferred but not essential. Replies confidential. Box 30, c/o Secretary, R.I.B.A.

Associate (41) seeks partnership in Edinburgh or within 50 miles' radius. Capital available if required. Car owner. Box 33, c/o Secretary, R.I.B.A.

Young Associate with extremely varied experience seeks junior partnership or position leading thereto in London firm. Capital available. Box 38, c/o Secretary, R.I.B.A.

Associate (34), with experience of large contracts and good contemporary design, seeks partnership. Some capital available. Box 39, c/o Secretary, R.I.B.A.

Architect retiring from his practice, which he started over 50 years ago in small town in the S.W. region, is considering selling same, or partnership. Opening for young architect anxious to build up a practice. Box 31, c/o Secretary, R.I.B.A.

Fellow with London West End practice has senior or junior partnership to offer preferably to member with existing connections. Would consider amalgamation with another member in practice. Box 34, c/o Secretary, R.I.B.A.

Fellow with well-established practice in Croydon offers senior position in his office with view to partnership. Box 37, c/o Secretary, R.I.B.A.

WANTED AND FOR SALE

Wanted. Secondhand plan chest. Please state size, height and price. Box 32, c/o Secretary, R.I.B.A.

For sale. Double Elephant 'Compactable' drawing stand and adjustable stool. Good condition. £7. RIChmond 3626 or Box 36, c/o Secretary, R.I.B.A.

ACCOMMODATION

Accommodation to let in Seymour Street, London, W.1. 5 rooms (1200 sq. ft.). Ground floor and basement. 'Phone AMBassador 2254 or write Box 35, c/o Secretary, R.I.B.A. for further details.

MISCELLANEOUS

Leading French architect would like to arrange exchange for eighteen-year-old architectural student son with English family for summer months. Further particulars from the Secretary, R.I.B.A.

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